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A PHYSIOLOGICAL STUDY OF DELAYED GERMINATION IN COTTON

By R. BALASUBRAHMANYAN, B.A., B.Sc., (Ag).,

& V. RAMASWAMI MUDALIAR, B.A.,

Assistants to the Cotton Specialist.

Introduction: During the year 1930, a second generation of an interspecific cross, exhibited poor and delayed germination, while other crosses between different parents had uniform and quick sprouting. A large number of seedlings continued to come up even at the end of a month, often with their cotyledons enclosed in the seedcoat, in spite of the adequate moisture in the soil. These contributed very little to the yield, and their behaviour was very much similar to the second sown crop (*Plate II. Fig. 2*).

One of the criteria for a good and successful crop production lies in good and rapid germination followed by early growth. The disadvantages of a variety possessing delayed and protracted germination are many. It necessitates not only an initial high seed rate to ensure

a good stand, but also forms a prospective nuisance in later years, as weed. Haphazard sprouting produces many weaklings which contribute very little to the yield besides delaying the general harvest of the crop.

The remarkable ability of certain seeds of cultivated and wild plants to remain viable for nearly half a century, even when lying buried in the soil, is a sufficient proof that dormancy is one of Nature's adaptations for securing longevity in seeds. The delay is in general more persistent in the wild types than in the cultivated races. The conscious selection pursued by man in his endeavour to domesticate and produce better varieties, has reduced to a minimum the rest period following a freshly harvested crop. Many of the present day cultivated varieties are marked by the complete absence of this quiescent period, and the continued presence of dormant seeds has been traced to both developmental and environmental causes.

Review of Literature: During recent years the enquiries have been centred round two main phases of the problem, viz., (1) the various methods by which dormancy is produced in Nature, (2) the exact conditions that are necessary for the maintainence of viability in seeds for a very long interval, and the conditions that force the germination of such seeds by modifying certain inhibiting factors.

The question of the influence of environment on the production of impermeability in seeds, has been debated for a very long time. A close relation between the moisture content, environment, and hardness has been noticed. Rose (1919) on Sambucus, and Toole and Drummond (1924) on cotton observed the onset of hardness when the moisture content of the seed fell below six per cent. Hiltner referred to by Croker (1919), and Bredeman (1931), found more hard seeds in dry periods and in dry climates. Jones (1928) concluded that the early vigour of the plant influenced the production of the hard seeds. It has also been found that the total water requirements of hard seeds are generally high. Guppy (1912), and Miazdticova (1932), showed that good permeable seeds required less water for germination than poor and delayed types. Youngman (1929), drew attention to the specific quantities of water needed for germination, and its relation to the climate under which each variety throve well.

The modes of securing this delay are varied and numerous, but they are generally found in the seed coat or the embryo. An interesting turn was given during recent years to this problem, as to the relative importance of these two plant parts in inducing the dormancy, but the volume of evidence adduced by numerous workers, point towards the seed-coat as playing a more important role. Ewart (1908) suggested a hypothesis that was incapable of experimental verification, that 'longevity depended upon how long the dry dormant protoplasm

of the embryo was able to recombine and re-establish the molecular groupings of the proteid matter when remistened, and proceed with normal activity'. Crocker (1916) showed that 'loss of viability of seeds approaching air dry condition, is due to slow denaturing, or coagulation, of certain protoplasmic substances of the embryo'. The same author showed that delay in hard seeds might result from restricted absorption of water, low permeability to gases, or mechanical restraint by the seed-coat, or from rudimentary embryos.

Various substances in the seed-coat, and certain structural adaptations have been found responsible for the exclusion of water. Bergtheil and Day (1907), and Braun (1924), found the hardness was due to the presence of a thin cuticle. Jarzyomowski (1905), Coe and Martin (1920), Ohga (1925), Lute (1928), Reeves and Valle (1932), and Shaw (1932), each working with a different type of seed demonstrated that the light zone of the modified palisade, or the whole palisade layer of the seed-coat was of low permeability, on account of the reduced size of the lumina in these cells. The impermeability was to a large extent removed when the tips of the malpighian cells were broken by some mechanical means. Collins (1918) showed that there were restricted zones of absorption and transmission of water in barley, due to the structural peculiarities of the seed-coat. Shull and Shull (1932) attributed the irregularities in the water intake of hard seeds to the non-homogeneity of the coat and the contents. Denny (1917) demonstrated the reduced water absorption due to the presence of pectic compounds, lipoids, and tannins. Harrington and Crocker (1923), and Verschaffelt quoted by Crocker (1916), found the micropyle closed in certain types of impermeable seeds.

Again the seed-coat sometimes limited the exchange of gases, and thereby induced delay. Crocker (1906), and Shull (1911), found that the exclusion of oxygen needed for the embryo, raised the minimum temperature necessary for the germination, and that high temperatures generally increased the rate of oxygen and carbon-di-oxide diffusion. Shull (1911), and Atwood (1914), obtained increased germinations under high oxygen pressures, or when the coat was opened. Kidd and West (1917, 1920) showed that the gaseous exchange was lower in a thick or unripe testa, and that a higher concentration of carbon di-oxide found in certain soils inhibited germination.

In other cases where the water entered the coat readily, but yet resulted in delay, the causes have been traced to the mechanical restraint of the seed-coat. Muller quoted by Crocker (1916), and Crocker and Davis (1914) with Alisma, found that the breaking strength of the water saturated seed-coat was considerably in excess of the imbibitional and osmotic pressures of the embryo at the time of germination. Harrington and Crocker (1923), and Ives (1923), obtained a better germination when the pericarps were removed.

Many of the seed-coat characters respond to the treatments, and the nature of the treatment greatly depends upon the nature of the defect. Rose (1915) has reviewed the various treatments with sulphuric acid, puncturing, and scarification. The existence of such mechanical treatments on a commercial scale for the herbage seeds on the Continent, is a sufficient proof for the better crops obtained with such treated seeds. The treatments primarily reduce the seed-coat thickness, and rarely alter its composition. Nye (1929) obtained a high and quick germination when treated with sulphuric acid. Dilute acids and bases act on the colloids of the seed-coat and increase their water holding capacity by dispersing them, but Eckerson attributed the effect of these acids to the hypocotyl portion of the seedling. The increased absorption and germination noticed by Davis (1917), Shull (1920), Harrington (1921), and Evans (1922), under high temperatures during germination are due to both the breaking up of the colloids and rapid diffusion of gases.

A number of varieties have been noted to possess dormant or weak embryos. Dormant embryo improves after storage, but weak embryo which generally results from the wide crosses, germinates readily. Dry heating as a method to hasten after-ripening has been widely used with varying results. Dixon (1902), and Harrington and Crocker (1918), noticed that the time needed for germination increased with exposure to high temperatures, and the latter hence concluded that Ewart's hypothesis about the protoplasm of the embryo, could not be a correct view. Groves (1917), and Jones and Tincker (1926), observed a gradual decrease in the percentage of germination with increased time of heating. David and Rose (1912), and Eckerson (1913), have shown that the changes in the after-ripening consisted in increased water holding capacity, increased activity of the catalase and oxidase. Harlan and Pope (1925) on barley, and Lyons (1928) on wheat, observed lack of embryo development in a small percentage of seeds although the endosperm was normal.

A big embryo implies a big reserve for the growing seedling, and this is possessed generally by big and heavy seeds. Blackman (1919), and Ashby (1930), showed the advantages possessed by a larger seedling over a smaller one, since the growth might be viewed as an exponential function of increments. A correlation between the heavy seed and the subsequent growth has been established by Ewing (1910), Rudolphs (1923), and Williams (1927). Harris (1912), demonstrated the existence of selective mortality in beans, such that the light and very heavy seeds were weeded out leaving the mean of the viable seeds unchanged.

It may be seen from the review of literature given above that the modes of securing the dormancy in seeds, are not confined to the dull

monotony of one single method. An enquiry into the factors that caused the delay in germination in our material was therefore taken up.

Material. The following five varieties covering the parents and the crosses formed the material for the various experiments.

1.	Strain N 14 (*G. indicum*) hereafter referred to as variety			I.
2.	Strain 2113 (*G. herbaceum*)	,,	,,	II.
3.	Garo-hill cotton (*G. Cernuum*)	,,	,,	III.
4.	Isolated hybrid from *G. indicum* × *G. Cernuum* – (I × C 99)	,,	,,	IV.
5.	F_1 progeny (2113 × I × C 99)	,,	,,	V.

Methods. A large number of workers on this problem have used the rate of water imbibition as an index of impermeability in seeds, and in the experiments described below, the same measure is adopted. Random samples of one hundred good seeds from each treatment was placed between moist blotting sheets in germination trays. Progressive weights were recorded every four hours till there was no further absorption or germination. The emergence of the radicle to a length of five millimetres was taken as full germination, and such seedlings were removed as they were recorded so that the water absorbed was really the water necessary for the germination of the remaining seeds. The percentage increase in weights on the initial dry weight of seeds, was calculated and compared.

The influence of the coat properties on the rates of absorption in untreated seeds, when definite portions of the seed-coat were exposed, and when treated in different ways, were found. Other experiments were conducted to find the relation between the delay in germination, and the defects in the seed coat and embryo, when the water was normally absorbed.

Rates of Water intake: The five varieties exhibited inherent differences in the rate and total absorption of water. The curves of absorption (*Plate I. Fig. 1*) fall into two groups, viz., (1) for varieties I and II, and (2) for varieties III, IV, and V. The former group showed a substantial increase at the end of four hours followed by a rapid rise, and reached the upper saturation point before fifty-two hours. In contrast to this, the other group started absorption late, progressed slow, and touched the point of full saturation at the end of seventy-two hours. This group, continued to absorb even after the close of germination, and later studies on the embryo showed that such continuous absorption may be due to the empty spaces in the seed between the partially filled embryo and the seed-coat. Poor and delayed germinations resulted from the low rates of intake.

The differential permeabilities of the seed coats of different varieties, were found by blocking the micropyle with melted paraffin. Varieties IV and V (Plate I fig. I), showed the same rates of absorption as untreated seeds, while a perceptible fall was noticed in the other three varieties. The possible interference by the varying density of fuzz on seed was eliminated by treating the seeds with concentrated sulphuric acid. The behaviour of such treated seeds in the delayed lots, with or without closing the micropyle was in entire agreement with the other results. This experiment showed that in varieties IV and V, the micropyle did not function as a channel of water intake, and that the whole absorption was limited to the seed coat alone.

The rates of absorption through the micropyle, and the chalazal end, were determined. For this purpose the seeds were suspended on paraffin-coated paper floats, well cemented with a mixture of paraffin and wax, and the ends were just immersed in water, leaving the other portions of the seed free and dry on the float. Empty floats were used as controls, to find their absorption, and later correction. The results given (plate I fig. I). are very interesting and demonstrate the long initial delay in absorbing, low rise, and low total absorption particularly in varieties IV and V. The two varieties I and II, take in water readily both through micropyle and chalazal end.

This set of experiments prove that the varieties exhibit different absorption rates, and that the delay is partly due to the closed micropyle and low permeability of the seed coat.

Chemical properties of the seed coat. Hand sections of the seed coat were examined. and micro-chemical tests were tried with a view to find the chemical nature of the seed coats in these varieties. The presence of cutin was negatived by the action of Sudan III, and alcoholic solution of chlorophyll. There was no tannin or pectic compounds. Dilute acids and bases showed a tendency to break apart the seed coat at the junction of the palisade and the inner epidermis, more readily in the permeable group. This might be due to the looser arrangement of the cells or to the presence of less binding material. Cuprammonia dissolved very quickly the unthickened portion of the palisade in varieties I and II, and the quickness with which the walls went into solution, could be seen from the number of brown masses shooting out of the palisade. The 'light zone' of the palisade often referred to by other writers was very prominent in the hard seeds due mostly to the greater thickening and deposit of lignin. The lumen of the palisade in the permeable and impermeable groups was completely disorganised by concentrated sulphuric acid in about three and eight hours respectively. The brown pigment layer probably resisted the acid action in the latter.

Hard seeds were not different with regard to their moisture content from other seeds, but their ash contents (Table IV) were low, probably due to the greater amount of organic colloids.

Mechanical restraint imposed by the coat. It is commonly known that the seed coat is weakest at its full water holding capacity. The rates of absorption (Table I) for the seed coats only when the contents are removed, show that in addition to the low rate of water intake, there is higher saturation point for the impermeable varieties. The emergence of the radicle in such delayed varieties, does not synchronise with the rupture of the coat, showing that the pressure of the embryo is not sufficient to break through the seed coat. An attempt was made to follow the changes in the strength of the coat at different water contents, but the experimental error was very high that the differences were unreliable.

The toughness or hardness of dry coats was also measured with the apparatus designed by Puri and Venkataraman. Weights were slowly added till a puncture in the seed coat was made by the pin resting on it. The average pressure required to puncture through the seed coat at the mid point on the dorsal side of one hundred seeds of each variety was found. Impermeable varieties have a higher scale of hardness.

It was found that the thickness of the seed coat measured on median cross sections (Table IV) followed closely the gradation of permeability and hardness.

Hardness is also conditioned by the presence of certain substances like cutin, lignin, etc., which lower the elasticity of the structure. The elasticity or the precentage stretching power of the coat was determined, by finding the percentage increase in the dimensions of the soaked seed, after fixed intervals of one and two days. The maximum distension (Table IV) is obtained with varieties I and II, at the end of a day, and moderately high increase with the other two during the same interval. The low elasticity of the coat will resist the swelling by imbibitional and osmotic forces of the normal embryo. The necessary pressure for breaking the coat fails to develop, and leads to delay in germination.

Methods of overcoming the seed coat defects. Partial removal of the seed coat, reduction of the seed coat thickness, and modifying its colloidal nature, were tried.

The embryo was made to absorb water directly by removal of the seed coat at the butt end of the seed. The rates of absorption are very high (Plate I. fig 1) in all the varieties, as the limiting agency of the seed coat has been removed. The embryo greedily absorbed water and swelled rapidly. The radicle in hard varieties emerged through the cut end taking a curved path ; while they emerged through the micropyle in other varieties.

Strong commercial sulphuric acid was allowed to act upon the seed for intervals of 15, 30, 60, 90, 120, 150, minutes. The rates of water intake (Plate II. fig 1) show a steady and progressive increase in varieties IV, and V till 150′ treatment, whereas this increase in varieties I and II, is absent beyond 15′ treatment. Treatment up to 15′ only removed the fuzz adhering to the seed coat. The slow action of the sulphuric acid on hard seed coats seems to be due to a difference in its composition. The increased rate and total germination (Table I) obtained, for varieties III, IV, and V, in the two experiments indicate the bad effects of such hard seed coats in untreated seeds.

Constant temperatures of 28, 35. 40, and 45, degrees centigrade were maintained with an incubator. The rate of absorption increased with rise in temperature (Plate I. fig 2), in all the varieties, and the germination (Table III) also increased in varieties IV, and V, up to 40 degrees. Though there appears to be definite lethal temperatures for the different varieties, hard types possess a higher optimum for germination. The radicle was injured at 35 degrees in varieties I to III, and it was seen just as a white speck lacking growth.

Characters of the embryo. The size and weight of the embryo influence the germination. It was suspected that poor embryo development might be responsible for part of the poor and delayed germination in the varieties, and to test this possiblity, the proportional weights of the embryo and the seed coat for the different varieties (Table V), and for the different seed weight groups (Table VI), for variety V, were determined. It may be seen that the delayed varieties have a lower proportion of the embryo to the seed coat, than varieties I and II. The variability of the embryo in hard seeds is nearly double that of the permeable group, while the variability of the seed coat is practically unaffected. The proportion of the embryo to the seed coat in different seed weight groups shows that 3·2 % of the normal looking seeds lack embryo, and nearly 34 % possess embryos arrested at varying stages of development. The disparity in the proportional weights of the embryo and the seed coat, is gradually lessened from the lighter seeds to medium heavy seeds. Owing to the difference in their structure and composition, an equal rise in the weight of the seed coat and the embryo will not proportionately increase the breaking strength of the former and the swelling pressure of the latter. Each small addition to the coat will increase its chances for delay in germination.

In order to test this hypothesis 2000 single healthy seeds from variety V were weighed and grouped according to seed weights. These were sown in small bed and kept watered through out the experiment. The record of germination was maintained up to twentieth day after sowing, and as soon as the seedling emerged, it was classified as normal or shrunken. The proportion of normal seedlings in relation to the total germination (Plate II. fig 2). from each of the

seed weight groups, show a rise till 85 mgs., and a fall to zero later. An average difference to four days in the time taken to germinate was obtained between the normal and shrunken seedlings, and this difference would be very much increased under rapidly drying field conditions. The form and nature of the curve obtained for the germination add weight to the previous hypothesis that the delay and failures in light seeds are due to poor embryo, and that in heavy seeds, due to thick and unyielding seed coats. The maximum germination composed of good seedlings is obtained from average seed weights, due to the balanced development of the seed coat and the embryo. The embryo in light seeds was very variable, but in medium seeds and heavy seeds, the variability was very low.

Another cause for the delay may be the dormancy of the embryo, which sometimes requires after ripening. Dry heating the seeds brings about this change earlier. Short exposures of one and three hours at 50 degrees centigrade, and a long exposure of forty eight hours at 40 degrees were given. The results obtained were not consistent, and generally the rates of absorption were either decreased or remained unaffected. A slight forcing effect at long exposures (Table III) was noticed in varieties I and II, while varieties IV and V, exhibited a reduction in total germination.

Discussion. The factors causing delay in germination in the material under study, have been traced to both seed coat and embryo. The environmental and developmental causes leading to the presence of such hard seeds have been noted to be (1) an unusally dry period during the phase of crop maturation, and (2) the extra vigour of the plant in the early stages of its growth. As all the varieties were raised during the same season, the climate does not seem to be the casual factor. It was shown that the F-1 plants were vigorous, and it is very likely that these fast growing vigorous plants utilised the moisture available in the soil very rapidly and met with a scarcity at the fruiting period in the same manner as found by Jones in vetch. In addition, the early and quick development of thick seed coats in such types, may have adversely affected the development of the embryo.

The wide range of variability of the embryo weights in I × C 99, (although in its nineth generation), is probably due to the union of dissimilar gametes, because the two parents of this cross do not show such high variabilities. The percentage of empty seeds is very much higher than the figure obtained by Lyons for wheat. Failures in hybrid are maximum in light and very heavy seeds, and this result is similar to that found by Harris in phaseolus, but the causes of such failures appear to be different, viz; (1) due to the poor embryo in light seeds, and (2) due to thick impermeable seed coats in heavy seeds resisting the force of the expanding contents. The lower rate of

absorption is partly due to the restricted transmission by the hard seed coat, and partly the result of slow absorption by the poor embryo through the two points of contact with the seed coat at the micropylar and chalazal ends. The embryo, however small or weak, readily absorbed and germinated when the seed coat was opened, showing that it was not dormant.

The differences in the rate and total quantity of water absorbed by the varieties, are due to the differences in the composition of the seed coat, and the environmental adaptations. A rapid absorption and a lower demand for water in *G. indicum* and *G. herbaceum*, are indispensable for their continuous survival, because they are generally found in dry places with rainfall not exceeding 30 inches, most of which are received in small quantities. The higher minimum water needed for germination by *G. Cernuum*, and its crosses are perhaps adaptations to the heavy downpours received during the year, in their native habitat (Assam). Part of the higher requirements in the hard seeds, may also be due to empty spaces between the weak embryo and the seed coat which gradually get filled up with water, or due to the colloidal composition of such coats.

The delay in the permeable seeds is due to the high breaking strength of the seed coat. The observations in the laboratory where the radicle emerged through the cut butt ends, and the germination of late seedlings in the field with the unbroken seed coats; are due to the failure of the embryo to develop the requisite pressure.

The various causes indicated, and the various methods tried in this paper to quicken and improve the total germination, show that the varieties possessing good embryo with hard seed coats, could be modified to produce a more vigourous and better crop. On the other hand, those containing weak embryos could only be induced to germinate without very much adding to the yield.

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Summary. (1) Delayed germination was observed in an interspecific cross in cotton. (2) The rate of water absorption was associated with the rate and total germination. The parents were differently permeable to water and this was inherited by the hybrid. (3) The minimum quantity of water required for hard seeds was very high in comparison to others. Hard seeds limited or excluded water on account of closed micropyle, or the reduced size of the lumen in the palisade cells. (5) The breaking strength of the coats was high

and the embryo was generally unable to develop this pressure by swelling. (6) Reduction of seed coat thickness by carbonisation, or removal of a portion of the seed coat, increased the germination. (7) Better germinations at higher temperatures were obtained with hard seeds. (8) The composition of the seedcoat is probably colloidal in nature, and this is shown by the low stretching power, high breaking strength and low ash contents. (9) The apparent vigour of the first generation hybrid resulted in the production of hard and thick seed coats. (10) The embryo development in the hybrid was very variable, and about 4% lacked embryos. (11) The proportion of healthy seedlings was most in medium heavy seeds, and the total germination was equally high here (12) Weeding out of heavy and light seeds was likely under normal conditions due to the defects in the seed coat and the embryo. (13) The embryo in hard seeds was only partially developed and occupied only a portion of the seed cavity. The seed coat transmitted water in hard seeds with poor embryo, through the two points of contact only, resulting in slow germination. (14) The embryo was not dormant but was only weak. Dry heating protracted the germination or had no effect.

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Table I.

Percentage Germination.

No. of	Untreated at 28 C.					Open at chalayal end.					Untreated and micro-pyle closed.					Delinted and micro-pyle closed.					Seed-Coat alone ** (Embryo removed).				
hours.	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
24	...	...	...	...	...	...	...	...	...	...	12	10	...	...	...	12	10	...	...	...	79	49	53	48	41
28	...	...	...	...	...	28	31	7	5	4	32	34	...	...	...	32	34	...	...	...	88	54	60	53	47
32	50	...	...	...	...	57	51	16	16	14	58	62	9	10	20	58	62	9	10	20	90	56	71	63	49
36	55	...	...	...	...	84	95	23	23	23	72	86	23	20	32	72	86	23	20	32	...	64	79	70	55
40	83	...	...	...	...	91	97	57	42	51	80	88	41	25	39	80	88	41	25	39	...	66	84	75	60
44	88	3	2	...	6	...	...	65	69	63	85	90	51	34	46	85	90	51	34	46	...	68	92	79	66
48	94	48	5	6	12	...	...	82	75	75	87	94	62	44	48	87	94	62	44	48	...	...	97	81	73
52	...	89	17	16	16	...	...	84	83	81	87	94	72	52	59	...	...	72	52	59	...	...	106	86	76
56	...	90	31	24	26	...	...	86	85	88	87	94	76	52	59	...	...	76	52	59	...	...	108	90	83
60	...	95	39	26	38	...	...	86	85	89	87	94	78	52	62	...	...	78	52	62	...	...	...	94	87
64	...	...	57	34	40	...	...	87	85	91	87	...	78	56	64	...	...	...	56	64	...	...	...	99	91
68	...	...	75	36	40	...	...	87	85	91	...	...	78	58	64	...	...	...	58	64	...	...	...	104	99
72	...	...	75	36	40	...	...	87	85	93	...	...	78	58	64	...	...	...	58	...	...	...	...	108	103
76	...	...	80	38	44	...	...	88	85	93	...	...	78	60	64	...	...	...	60	...	...	...	...	112	109
80	...	...	...	38	48	...	...	...	...	...	...	...	...	60	64	...	...	...	...	...	...	...	...	114	115
84	...	...	...	40	58	...	...	...	...	...	...	...	...	60	64	...	...	...	...	...	...	...	...	...	...
88	...	...	...	40	...	...	...	...	...	...	...	...	...	60	...	...	...	...	...	...	...	...	...	...	...
92	...	...	...	44	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
96	...	...	...	46	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

* Percentage moisture absorbed.

Table II.

Percentage Germination.

No. of hours.	Delinted with H_2SO_4 15 mts.					Delinted with H_2SO_4 30 mts.					Delinted with H_2SO_4 60 mts.					Delinted with H_2SO_4 90 mts.					Delinted with H_2SO_4 120 mts.					Delinted with H_2SO_4 150 mts.				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
16	4	4	...	...	...	4	8	...	...	...	6	2	...	...	...	4	4	...	...	...	4	8	...	...	...	4	4	...	...	...
20	10	14	...	...	...	10	18	...	...	...	10	14	2	...	...	12	8	10	2	...	10	60	12	4	4	16	12	14	6	4
24	28	66	12	...	4	30	74	16	4	6	42	60	24	6	10	52	54	24	8	10	38	68	26	32	30	36	32	54	10	38
28	32	74	22	2	20	40	80	30	16	20	60	74	36	30	22	60	62	52	36	44	64	76	46	62	64	60	70	76	34	60
32	58	82	50	12	28	74	86	54	38	28	72	76	56	56	44	78	78	60	64	54	72	82	62	70	86	76	76	86	38	82
36	72	88	52	30	44	84	92	56	44	44	88	78	68	76	48	82	84	64	76	62	82	88	70	74	88	80	88	90	72	84
40	84	...	56	30	46	...	96	62	46	48	...	80	74	78	62	...	...	72	82	68	...	...	74	78	90	...	...	90	80	92
44	...	...	60	30	50	...	...	70	48	60	...	...	80	78	70	...	...	76	86	72	...	...	84	86	90	...	...	...	90	96
48	...	...	66	34	52	...	...	76	54	62	...	...	84	78	76	...	...	80	...	74	...	...	...	...	90	...	...	...	90	96
52	...	...	78	42	58	...	...	84	58	66	...	...	...	80	...	...	...	...	...	76	...	...	...	...	...	...	...	...	...	...
56	...	...	...	46	60	...	...	...	60	68	...	...	...	...	...	...	...	...	...	82	...	...	...	...	...	...	...	...	...	...
60	...	...	...	52	62	...	...	...	62	70																				
64	...	...	...	54	68	...	...	...	68	72																				
68	...	...	...	56	70	...	...	...	70	78																				
72	...	...	...	56	72	...	...	...	...	78																				
76	...	...	...	...	72	...	...	...	...	...																				
80																														
84																														
88																														
92																														
96																														

Table III.

Percentage Germination.

No. of hours.	Maintained at 35°C.					Maintained at 40°C					Maintained at 45°C.				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
20	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
24	...	...	...	...	...	8	...	...	...	...	...	...	...	...	...
28	29	...	...	...	...	28	...	...	2	...	...	...	...	...	...
32	73	8	...	5	...	59	...	...	10	...	2	1	...	1	...
36	84	27	6	15	2	65	3	...	40	1	26	3	...	6	...
40	92	70	15	30	14	69	60	2	55	1	31	12	...	15	...
44	...	87	42	42	26	71	81	12	74	2	36	41	1	29	...
48	...	94	63	43	48	73	93	30	84	7	41	64	2	43	...
52	...	95	64	45	57	75	94	50	85	19	45	81	12	69	1
56	...	...	70	46	61	...	...	55	85	38	...	82	24	70	3
60	...	...	73	46	64	...	...	58	86	64	...	...	28	74	3
64	...	...	75	47	64	...	...	63	...	81	...	...	29	78	16
68	...	...	...	...	64	...	...	65	...	90	...	...	33	...	20
72	...	...	...	...	64	...	...	...	...	91	...	...	...	...	36
76	...	...	...	...	...	...	...	...	...	...	...	...	...	...	59
80	...	...	...	...	...	...	...	...	...	...	...	...	...	...	66
84	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
88	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

No. of hours.	Maintained at 50°C.					Dry heated for 1 hour at 50°C.					Dry heated for 3 hours at 50°C.					Dry heated for 48 hours at 40°C.				
	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
32	...	...	...	...	...	6	...	...	...	...	4	...	...	...	...	14	2	...	2	...
36	...	...	...	...	...	14	...	...	...	...	16	...	...	2	...	44	8	...	2	...
40	...	...	...	...	...	56	...	...	4	...	60	...	...	6	...	62	28	...	14	...
44	...	...	...	1	...	78	6	2	16	...	78	6	...	12	...	64	40	4	14	...
48	...	...	...	2	...	80	34	4	26	...	84	34	4	20	2	68	50	12	24	2
52	...	...	...	2	...	82	82	20	34	2	...	82	12	40	4	70	70	40	30	6
56	...	...	...	3	6	...	86	46	42	12	...	86	40	44	22	70	90	62	32	8
60	...	...	...	...	6	...	...	60	50	18	...	...	54	50	24	70	92	68	...	16
64	...	...	...	...	...	...	...	72	58	42	...	...	60	54	42	...	...	74	...	32
68	...	...	...	...	...	...	...	76	...	48	...	...	...	56	48	...	...	76	...	46
72	...	...	...	...	...	...	...	82	...	66	...	...	...	...	56	...	...	78	...	46
76	...	...	...	...	...	...	...	...	...	76	...	...	...	...	58	...	...	...	...	46
80	...	...	...	...	...	...	...	...	...	78	...	...	...	...	60	...	...	...	...	46
84	...	...	...	...	...	...	...	...	...	80	...	...	...	...	62	...	...	...	...	...
88	...	...	...	...	...	...	...	...	...	84	...	...	...	...	...	...	...	...	...	...

Table IV.

Selection No.		No. of determinations.	Average force required to puncture the seed cast in lbs.	Standard deviation.	Percentage increase in				Thickness of seed coat in ?	Percentage	
					Length		Breadth			Moisture	Ash
					1 day	2 days	1 day	2 days			
N. 14.	I.	100	7·10	0·80	22·5	23·0	20·5	22·0	276	9·14	3·22
2113	II.	100	6·45	0·81	21·5	22·0	18·0	18·5	304	8·87	3·10
G. Cernuum	III.	100	8·90	1·38	14·0	17·5	15·5	17·0	312	8·86	2·60
I × C99	IV.	100	8·75	1·08	9·5	15·5	8·5	14·0	328	8·90	2·49
(I × C99) × 2113 F_1	V.	100	10·80	1·25	5·5	7·0	5·0	8·5	358	8·11	2·57

Table V.

Selection No.		Percentage Weight.		Co-efficient of variability.	
		Seed-Coat	Embryo	Seed-Coat	Embryo
N. 14.	I.	48	52	12	11
2113	II.	50	50	11	11
G. Cernuum	III.	55	45	15	17
I × C 99	IV.	60	40	13	31
(I × C 99) × 2113 F	V.	57	43	19	32

Table VI.

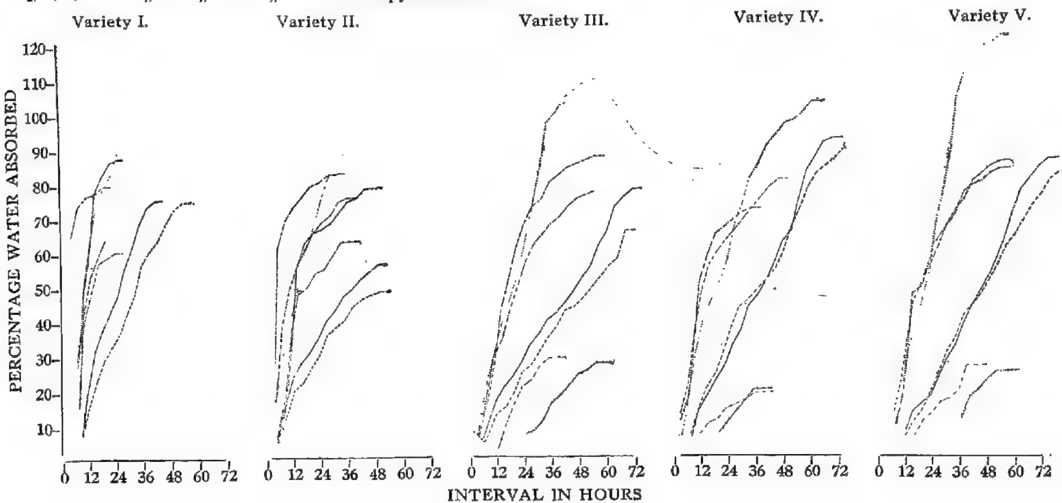
Seed weight in m. gms. per seed. (Variety V)	Seed coat weight in m. gms. per seed.	Embryo weight in m. gms. per seed.	Percentage weight of embryo.
35	31	4	11
45	38	7	16
55	43	12	22
65	38	27	41
75	41	34	46
85	47	38	45
95	52	43	46
105	57	48	46
115	64	51	44
125	69	56	45
135	80	55	41

Rate of water intake.

Role of Seed-Coat and Micropyle.

Plate I. Fig. 1.

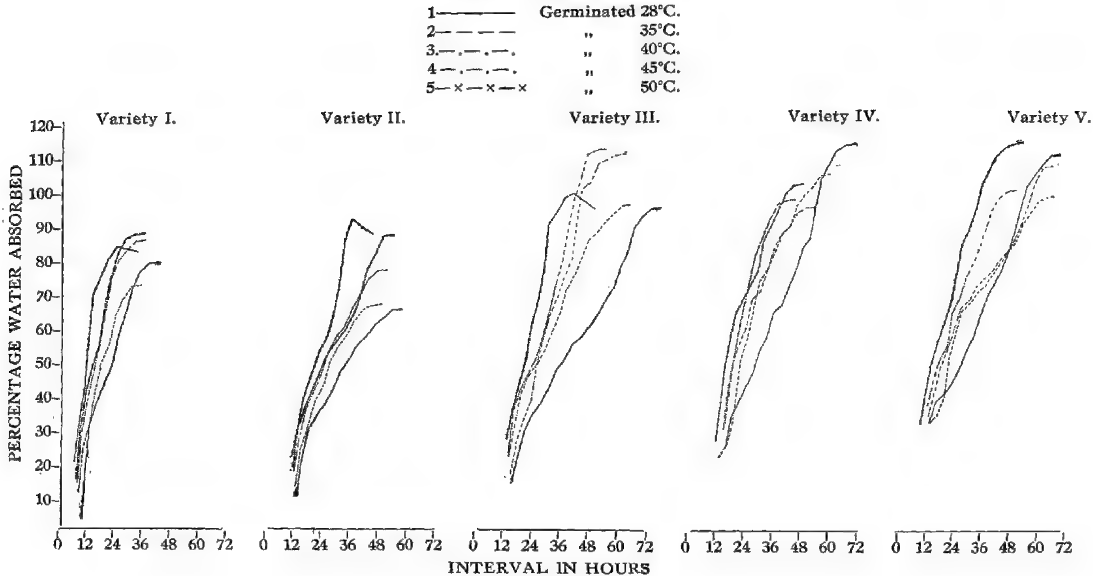
1.———untreated (Control).
2.- - - - - „ Micropyle blocked.
3.—.—.—.—Delinted with Conc H_2So_4.
4.—.—.—. „ „ „ Micropyle blocked.
5—×—×—Untreated Restricted absorption through Micropyle.
6..—..—.. „ „ Chalazal end.
7.............. „ „ Chalaza exposed.



Rate of water intake.

Effect of temperature.

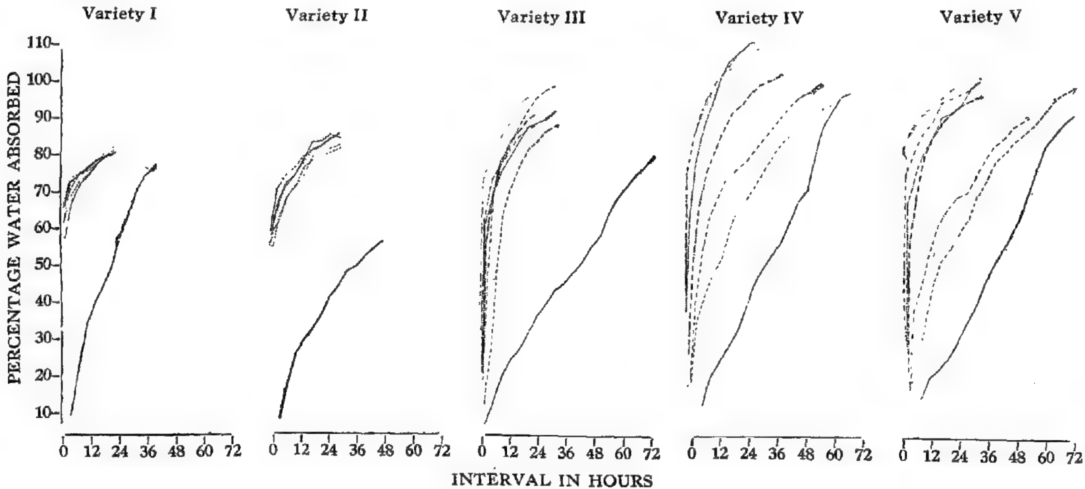
Plate I. Fig. 2.



Rate of water intake.

Effect of concentrated $H_2 So_4$ on Seed Coat. Plate II. Fig. 1.

1.———Untreated (control)
2.- - - - Treated with Conc. $H_2 So_4$ for 15 minutes.
3.—.—.—. " " " " 30 "
4.—.—.—. " " " " 60 "
5—×—×—Treated with Conc. $H_2 So_4$ for 90 minutes
6 ..—..—.. " " " " 120 "
7 .... " " " " 150 "



FLOWER & BOLL PRODUCTION

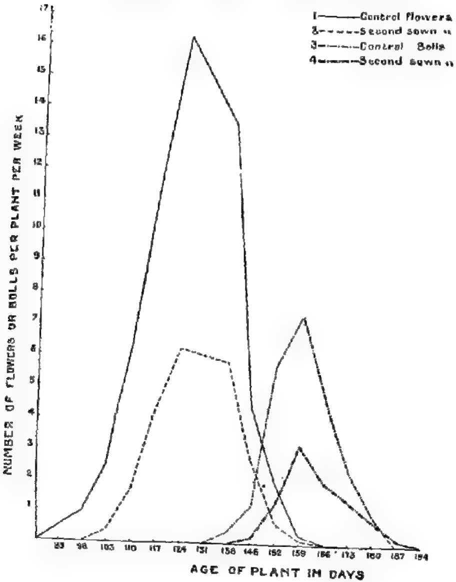
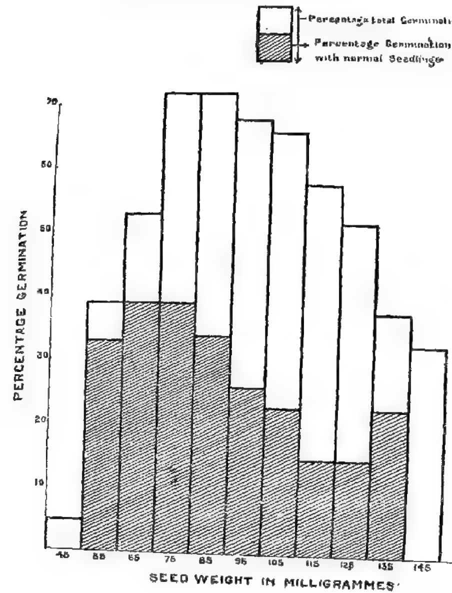


Plate II. Fig. 2.

SEED WEIGHT & GERMINATION



A STUDY OF THE ROOT SYSTEMS OF THE COMMON GRASSES AT THE LIVESTOCK RESEARCH STATION, HOSUR

By T. MURARI, B. Sc. (Oxon), F. L. S.

Superintendent, Livestock Research Station, Hosur.

Under tropical conditions the deciding factor for pasture is the moisture in the soil. In the localities where drought is regular, grasses that are adapted to resist longest will be the best suited for the locality. The grasses have mechanism for regulating evaporation of water from the lamina, and means to explore, in search of moisture and nutrition from the soil. It is with the object of knowing more about this aspect of the grass problems, that this study was taken up. The plants were individually very carefully dug up, their roots washed with water, air dried, and a number of measurements of roots taken. The results obtained are given in the table below :—

Name of grass	No. of plants studied.	Average length of roots	Depth to which they are seen penetrated	Area of the distribution of the roots	Nature of the adventitious roots	Remarks.
Andropogon contortus	42	1'8"	1'6"	1'9" × 1'9"	Thin, hairy & dense	Roots have lateral growth
Andropogon pertusus	27	2'6"	2'3"	15" × 15"	do	Runs vertically down
Cynodon dactylon	20	Indefinite traced to 3 feet	Indefinite traced to 3 feet	Very wide spreading	Thin, very sparsely distributed Rhizomes more prominant	
Digitaria sanguinale	16	1'3"	1'2"	15" × 12"	Thin, hairy & medium bushiness	
Pennisetum cenchroides	24	1'7"	1'3"	12" × 12" in one case even up to 18" × 16"	Thick roots, very sparse going vertically down into the soil	
Eragrostis sp.	18	9.5"	8"	10" × 10"	Thin & of medium bushiness	
Panicum sp.	18	8"	7"	10" × 10"	do	

From the above results, it will be seen that there are notable differences in the root systems of the various grasses studied. It is interesting to note that in some cases, the length of roots and the depth to which they penetrate are nearly equal. In others, the length is very great while the depth to which they penetrate is very shallow. It has not yet been possible to correlate the length of the root system with the type of soils, dry or wetland. It would however appear that grasses found in wetland have thin roots penetrating shallow. *Cynodon dactylon* on account of the indefinite length of roots and the indefinite depth to which they penetrate seems to resist not only drought but continue to grow despite the scraping of the ground or shieling method adopted by the grass cutters. On one occasion, the author noticed a root penetrating to a depth of well over 4 feet of sub-soil which was quite hard and dry.

Andropogon contortus is drought resisting to a remarkable degree. It does not seem to depend mainly on the depth to which the roots penetrate. The habit of growth is spreading and prostrate, excepting during the growing season, and it is able to control evaporation better than *Cynodon dactylon*. During the dry period it is often noticed that the cattle prefer the *Andropogon contortus* which is apparently dry to *Cynodon dactylon* which seemed more papery than leafy. It would be interesting to continue and extend the study to other grasses.

Note :— Farm Manager, Mr. A. H. Subramania Sarma, was in charge of this work. This note is adapted from the paper on " the Study of Pastures at Hosur " read by the author at the Indian Science Congress, 1932.

INTENSIVE MANURING OF PASTURES UNDER LOCAL CONDITIONS

By T. MURARI, B. Sc. (Oxon), F. L. S.

Superintendent, Live Stock Research Station, Hosur.

The object of this experiment was to force the growth of grasses under permanent pasture during the rainy season and thus increase the stocking capacity of the pasture; a pasture consisting of *Andropogon contortus. Andropogon pertusus*, *Digitaria sanguinale var. ciliaris* and *extensum* and *Indigoferas* was selected for the experiment. This had received 3 cwts. of lime in 1927 and 20 cartloads of Farm Yard Manure, 3 cwts. of Bonemeal, and 1 cwt. of Super phosphate in 1928. The experiment commenced in September 1929. Four ½ acre plots (A, B, C and D) in one square block, were fenced off for the manuring experiment, and pasture all round the experimental block was used as control. The plots were fenced so that animals could graze in rotation i. e. first A,

second B, then C and lastly D, back to A and so on. The rains began on 14th September and the rainfall for the month was 7·01 inches. There were about 11 rainy days during the month.

Eighteen Bull calves were chosen for the experiment; 9 as experimentals and 9 as controls. In each lot there were three of *Kangayams*, 3 of *Scindhes* and 3 of *Ongoles*. The grazing was done by tethering the animals.

The experiment started on 21—10—1929. The controls grazed outside the block and the experimentals in plot A. In addition to grazing, the animals received soiled guineagrass *ad lib*. Weights of each animal were taken twice a week

Plot A was grazed off by the 17th November, when the animals were changed to plot C. In the meantime plot D was sown and 960 lb. hay collected, and it received 56 lb. of sulphate of ammonia on the 25th November, so that the herbage could grow in time for the animals to be put on it.

Later, the animals were changed to plot D. As there was no rain the herbage in plot D did not grow and that plot and plot C became dry.

The experiment was completed on 5th December 1929. The weights of the animals are given below:—

A. Experimentals.

Calf No.	Breed.	Date of birth.	Weight on 21—10—29 lb.	Weight on 21—11—29 lb.	Weight on 5—12—29 lb.	Difference in weight up to	
						21—11—29 lb.	5—12—29 lb.
59	Kangayam	17—11—27	564	574	598	+10	+34
52	do	25—2—28	512	532	574	+20	+62
63	do	16—7—28	462	431	486	−31	+24
11	Scindhe	—11—27	512	497	560	−15	+48
13	do	—12—27	546	554	578	+8	+32
20	do	12—8—28	440	432	454	−8	+8
51	Ongole	27—9—28	490	469	504	−21	+18
50	do	25—8—28	525	502	497	−23	−25
127	do	24—10—28	469	442	500	−27	+31
			4520	4433	4751	−87	232

B. Controls.

Calf No.	Breed.	Date of birth.	Weight on 21—10—29 lb.	Weight on 21—11—29 lb.	Weight on 5—12—29 lb.	Difference in weight up to 21—11—29 lb.	Difference in weight up to 5—12—29 lb.
58	Kangayam.	7— 5—28	532	514	541	−18	+ 9
61	do	2— 7—28	455	430	483	−25	+28
53	do	28— 2—28	532	497	469	—35	—63
9	Scindhe.	— 11—27	588	554	602	—34	+14
10	do	— 11+27	638	630	655	— 8	+17
16	do	1— 4+28	567	539	557	—35	—10
49	Ongole.	15— 8—28	574	543	595	—31	+21
48	do	5— 8+28	520	490	564	—30	+44
44	do	28— 3+28	602	550	609	—52	+ 2
			5008	4740		—268	+62

It will be noticed that all the controls lost weight, while among the experimentals only 3 animals have gained a little on 21st November, but by the end of the experiment when grazing was scarce all but one in the experimentals gained weight, and all but 2 in the controls also gained weight, but not to the same extent. From the experience and experiment conducted here it would appear that (1) Intensive system of manuring and grazing as in temporate regions is not suited especially for *Andropogon contortus* and (2) moisture in the soil is the deciding factor in the growth of grasses.

Note · Farm Managers, Messrs. H. Narahari Rao and A. H. Subramania Sarma were in charge of the experiment. This note is adapted from the paper on " The Study of Pastures and Meadows at Hosur " read by the author at the Indian Science Congress 1932.

Notes and Comments.

1. The Agricultural College Day and Conference. We take this opportunity to inform our numerous readers and well-wishers that it has been arranged to convene the twenty-second College Day and Conference during the last week of July commencing on the 23th of that month. In this connection we are glad to announce that Dewan Bahadur Sir T. Vijayaraghavachary Avl., the Vice President of the Imperial Council, Agricultural Research of Delhi, has very kindly consented to preside over the function. On behalf of the Madras Agricultural Students' Union,—under the auspices of which the annual

function is held—we hereby extend our invitations to all the members of the Union, our subscribers and the numerous well-wishers of the Union to render their cordial co-operation by attending the function, contributing papers of Agricultural interest to be read and discussed at the conference, and thus help to make the function a success. It is hoped that it will be advantageous both to the authors of the papers and the Conference committee, if contributors will kindly arrange to send in their papers and abstracts to the Union Secretary sufficiently early, for the preparation and issue of the Conference agenda in advance.

2. **The Agricultural Department and the Provincial Budget meeting.** It is gratifying to note that at the recent Budget meetings in the Legislative Council, the Agricultural Department and its work did not suffer any adverse criticism worth noting, though it has been the fashion with some public men to generalise and find fault with the department as a whole without taking any trouble to study the state of affairs, before rushing to such conclusions. On the other hand the demand for more demonstration and publicity, and for additional demonstration farms in the different agricultural tracts, really goes to show that the work of the department has impressed the agriculturists to a considerable extent. We would invite such of the public spirited men as really take interest in such matters and as entertain any doubts as to the usefulness of the Agricultural Department, just to visit the Institute at Coimbatore or some of the Agricultural Research Stations in the moffusil, study what is being done there, realise the scope and limitations of scientific work, and then give expression to whatever remarks they may be pleased to offer, instead of hastening to broad generalisations and undeserving remarks. The department always welcomes reasonable remarks and well-meant constructive criticisms.

3. **Election to the University Syndicate.** We offer our hearty congratulations to M. R. Ry., Rao Bahadur M. R. Ramaswami Sivan Avl., on his re-election to the Madras University Syndicate, for a further term of three years from this month. We need hardly add that it is likewise an honour to the Agricultural Department wherein the Rao Bahadur has laboured for several years. No one can deny that Mr. Sivan has done a great deal to point out to the educational authorities, the need for the encouragement of higher education in Agriculture. His re-election to the executive body of the University, is therefore a source of gratification to those interested in agricultural education. We wish Mr. Sivan all success in this further period, of strenuous and useful work in the Syndicate.

4. **Farewell to the Final Year Students.** The Union started a convention this year, when under its auspices, a public meeting was held to bid suitable farewell to the final year students of the College. Of late, the running of the Journal, punctually and of a standard worthy

of its past traditions, has so completely engaged the time and labours of the honorary workers in the Committee and the Editorial Board, that some of the objects with which the Union was started, in the earlier years, have been all thrown into the back ground. A ceremony like the one arranged by the Union would serve to impress on all old students, that, now that chances of employment in the Department are getting scarcer, the Union is the only link that keeps all 'Old Boys' in living touch with the *Alma mater*. It is proposed to keep at the Union a record of addresses of all old students and their activities and we would be thankful if all old students would correspond with us and keep us informed of their movements.

We wish the out going students a bright future in their careers.

The Pykara Scheme and Agriculture. We had occasion to publish in the November 1932 issue of our Journal, a short abstract of an able lecture delivered by the Government Agricultural Chemist, on "A case for the Electro-chemical Fixation of Atmospheric Nitrogen". The inauguration of the Pykara Hydro-Electro Scheme by His Excellency the Governor of Madras, during the month, has added considerably to the importance of the subject of that lecture. Hydro-electric power is used in other countries for the fixation of atmospheric nitrogen, and there is no reason why, state-controlled and suitably administered, it should not be used in our country, for a similar purpose especially as our soils are highly deficient in organic nitrogen, and as every attempt should be made to harness natural resources for augmenting the supply. Besides the possibility of manufacture of nitrogenous fertilisers, the new Hydro-electric Scheme opens out a vista of promise for giving a stimulus to several cottage industries that could be economically run on power. We fervently hope, that the Pykara Scheme will be utilised to its maximum advantage, by all land-holders, large and small, and that agriculture in South India, would by its utilisation, become a more paying proposition, than it now is.

ABSTRACTS

Variation in the Potein Intake of Sheep in relation to Wool Growth. A. H. H. Fraser and J. A. F. Roberts (*Jour. of Agricultural Science*, London. 1933, vol. 23, pp. 97—107). There has been a certain amount of interesting discussion recently, regarding the relation between protein intake and wool development in sheep, with special reference to the synthesis of cystine which forms an important part of the wool protein; and the present authors have examined the question of the effect of different levels of protein feeding on the quantity and quality of wool produced, using two lots of 20 sheep each, fed indoors on equi-calorific diets, one of which contained 52% more digestible protein (in the form of soyabean-meal) than the other. Comparison of samples of wool taken from the two lots at the beginning and end of the experiment, (148 days) and fibre measurements including fineness, length, and fibre-weight showed that there was no

significant difference between the two groups in respect of any of the wool characteristics measured. In the case of the low protein group (given a basal ration containing a protein equivalent of 0·170 lbs.), it was found, that no less than 9·2% of the digestible protein fed, was recovered in the form of dry wool substance (46·1 lbs. of wool containing 6 lbs. of cystine corresponding to 1·19% of the weight of digestible protein fed). An increase of digestible protein above this limit made no difference to the rate of production of wool. The authors note that the optimum protein intake for wool production, is almost the same as the optimum protein intake for increase of body weight in the growing animal. Comparing the cystine content of the proteins fed and the wool produced by the low protein group, the authors believe that synthesis of cystine occurred, and suggest that this synthesis may be a special function of the wool follicle, which is rich in cystine. (C. N.)

The Vitamin B. content of different samples of Indian rice by Spruyt's Colorimetric method. S. Gosh and A. Dutt. (*Indian Jour. Med. Res.* 1933, vol. 20, pp. 863—868). During the course of investigations on the beri-beri problem of Bengal, the authors had occasion to analyse about 50 samples of different varieties of rice collected in or near Calcutta and also obtained from Burma. A modification of Spruyt's colorimetric method was adopted for the estimation of vitamin B content, and some interesting results were obtained. A sample of "*doshi*" twice-boiled rice (middle grade) with the husk removed, consisted of about 15% red coloured and 85% brownish grains. The colour index (as showing the vitamin content) of the red grains collected separately was found to be practically the same as that of the whole sample, viz. 161. The same rice, when polished showed a colour index of only 122. A middle grade "*balam*" unpolished rice gave a colour index of 196 and the same rice when polished had a colour-index of 166. The outer colour of rice is not, therefore, an indication of its increased vitamin B content, and a good deal depends upon the degree of polishing. The average of 24 samples of "*atap*" rice is 110, and the average of 22 samples of parboiled rice is 133. The samples of "*d'henki-hulled*" rice examined were found to possess a lower colour-index than "*mill-hulled*" rice, which appears to be contrary to the prevalent view in India. The most important factor affecting the vitamin B content of rice appears to be the degree of polishing to which the grains have been subjected. (C. N.)

Use of irrigation water on Farm crops. A. E. Palmer. (*Bulletin No. 125, new series of the Canadian Department of Agriculture*). The paper reports the results of experiments with the irrigation of wheat, alfalfa, potatoes, sugar beets and sunflowers, covering a period of from two to six years, conducted on a medium sandy clay loam soil at the Dominion Experimental Station, Lethbridge, Canada. The influence of different number of irrigations and of irrigations at different stages of growth of the crops. has been examined. No consistent difference was noted either in the cooking quality of potatoes or in the sugar-content of the beets, receiving different irrigation treatments. The experiments indicated that, including the available water in the soil at the begining of the season, wheat requires from 1·50 to 1·75 acre-feet of water, alfalfa 1·75 to 2·25 acre-feet and potatoes about 1·50 acre-feet to produce good crops. Soil moisture determinations made of each foot-depth of soil, to a depth of six feet, before and after each irrigation, showed that a six inch application of water, failed to penetrate into the soil to a depth of six feet in more than half the plots, when the soil moisture content was below 11% at the time of irrigation. With the moisture content between 11% and 13%, 60 to 70% of the observations, showed, that the water had penetrated to six feet. The water applied to almost all of the plots having a soil moisture content above 13%, went down six feet and more. (C. N.)

Effect of reduced oxygen pressure on Rice germination. Jenkin W. Jones (*Jour. Amer. Soc. Agronomy*, 1933, vol. 25 No. 1, pp. 69—81). A large acreage of the rice land in California is so foul with barnyard grass (*Echinochloa crusgalli*) and varieties, that special irrigation methods have been developed to control these weeds. The method of irrigation generally adopted, is to sow the rice broad-cast in the seed-bed submerged under water; the land is continuously submerged after seeding to an average depth of about 6 inches, until the rice is mature enough to be drained for harvest. Under these conditions, seed rice germinates, but, seedlings of most forms of barnyard grass are unable to emerge through the 6 inches of water. The draw back of this system of cultivation is, that germination of rice is poorer, and heavier rates of seeding are required to obtain good stands, than under the usual system of alternate flooding and draining of the seed-bed, in the early stages till the seedlings have emerged. It was noted that drilling in the seed, in a dry seed-bed followed by continuous submergence, produced very low germination, and the object of the present investigation was to examine the conditions influencing the rate of germination. The results were as follows:— (1) In the three years during which this work was conducted in the field, rice sown on the surface of the soil, and ½ inch and 1 inch deep, then continuously submerged, produced an average of 78·14, 20·00, and 2·66 % of seedlings respectively. No seedlings were obtained from seed sown 1½ or 2 or 2½ inches deep, and continuously submerged either in the field or in pots in the green house, except when oxygen was forced into the soil. (2) The results obtained from germination studies in pots into which oxygen was forced, indicate that a deficiency of oxygen is probably the principal factor causing a lack of normal germination in rice seed, sown at various depths and continuously submerged with water. The development of the radicle is initiated by a suitable supply of oxygen. (3) When continuously submerged, a ½ inch layer of clay adobe soil materially reduced the oxygen pressure and a layer 1 inch or more in depth reduced the oxygen pressure to a point at which normal germination did not occur. (4) The results indicate that surface seeding in the water is the best practice when rice is grown by continuous submergence. (C. N.)

The Influence of raw milk on Teeth and Growth. E. Sprawson (*Scottish Jour. of Agri. 1933*, vol. 16 pp. 23—31) The author quotes numerous instances to show that the use of raw milk is conducive to perfection of dental development and structure, as well as of the body as a whole, and confers an immunity to dental caries, which is accentuated in these days of high carbohydrate diet. Milk that has been pasteurised or sterilised, loses appreciably its dietetic value, in respect of the factors which bring about immunity and good health. The author shows how among the primitive races who suckled their young till past the time of eruption of the deciduous dentition, such as the Australian aborginals, African races, Eskimos and others, dental caries was unknown; and advocates, that raw milk should be continued upto not less than the age of 14 years. In connection with the supply of raw milk, care should be taken to obtain the milk only from tubercle-free animals (milk tested with the double intradermal test) so as to avoid infection with bovine tubercle. The milk of goats has much to recommend it, as goats are almost absolutely immune to tubercle. Goat's milk is relished by children and is particularly efficacious in providing immunity to dental caries. (C. N.)

The Nature of Phosphate Fixation in Soils.—M. C. Ford (*Jour. Amer. Soc. Agronomy*, 1933, Vol. 25. No. 2). It is well-known that soluble phosphates (like super) when applied to the soil are fixed in more or less insoluble forms; this fixation or "reversion" is especially great in laterite soils, where a good proportion of the applied phosphate is converted into forms which are insoluble and

unavailable for plant-growth. The author has examined the nature of the fixation of phosphates in the soil. using soils and certain minerals like *hematite* (Fe_2O_3), *goethite* or *limonite*, ($Fe_2O_3 . H_2O$), *bauxite* ($Al_2O_3 . x H_2O$), etc. which are believed to be influential in bringing about the reversion of phosphate. The soils fixed phosphorus in varying degrees in forms not easily soluble in sulphuric acid of pH 3·0. The phosphorus fixed by soils as calcium or magnesium phosphates, is readily soluble in weak solvents and thus quite available to plants; that which is fixed as ferric and aluminium phosphates by ferric and aluminium hydroxides, chlorides or sulphates, is at least in part easily hydrolysable and available to plants; while, that which is fixed by *goethite* (*limonite*) is very insoluble and only slowly available to plants; the phosphorus fixed by *bauxite* was of intermediate solubility. *Hematite* did not fix any phosphorus, and hence the dehydration of *goethite* (by heating) destroyed its phosphate fixing power. The partial dehydration of *bauxite* increased its fixing power. The phosphates formed with *goethite* and partially dehydrated *bauxite* were found on X-ray analysis to be crystalline; The great power for 'reversion' possessed by laterite soils is attributed to the presence of *goethite* (*limonite*), *bauxite* and similar minerals. Heating soils to 185°F, destroyed the "reversion" power or the power to fix in insoluble forms, probably due to dehydration of *goethite*. The amount of *goethite* present is believed to vary greatly in different soils, and to persist in soils when once formed, because of insufficient heat in soils to dehydrate it. (C. N.)

Correspondence.

I

Spike Disease in Sandal.

Mr. P. S. Jivanna Rao writes to us as follows:-

The issue for November 1932 of the M. A. J., contains a summary of a lecture on the above disease, by Mr. M. Sreenivasayya of Bangalore and of the concluding address by the chairman, Rao Bahadur K. R. Venkatarama Ayyar, in which the impression is created, that spike disease has been definitely proved as communicable and that a 'death blow' has been given to the physiological theory. As a reference has been made to me, by the chairman, as an exponent of the physiological theory, and that theory was apparently not explained in all its aspects, I crave space for giving a brief summary of the theory, based on exact studies and observations made by myself and by various officers from time to time, the correctness of which cannot be questioned, and at the same time to point out some difficulties in our accepting the infection theory.

I. THE PHYSIOLOGICAL THEORY

1 Sandal is an obligate parasite and the haustoria are the chief organs of absorption.

2. In diseased plants, the haustoria and root ends are dead and the shoots are alive till the last stages; i. e., the plant dies and dries from the root upwards.

3. Though sandal indiscriminately attacks all kinds of hosts viz., dicotyledons and monocotyledons; herbs, shrubs, and trees and even such unprofitable substances as pebbles, sticks etc., those which are physiologically unfit, later free themselves from the parasite, in evidence whereof are the numerous scars found on the host roots e. g. Lantana. The haustoria consequently die of water starvation.

4. The real trouble with sandal, therefore, is in the absorbing system of which the haustoria are the most essential parts, and the death of these is the

root cause of the trouble, which becomes acute when an undesirable host like Lantana, dominates to the exclusion of other species

5. The exact manner of spike formation is as follows:- The death of the haustoria leads to shortage of water and its ultimate stoppage; the carbohydrate material formed in photosynthesis accumulates as starch, instead of being translocated as sugar, as this is a function of the transpiration current which is extremely slow; the leaf cells gradually cease to divide and this is followed by loss of turgidity. plasmolysis, death and desiccation. The plant is really 'roasted alive' due to the peculiar weakness of the root system.

The opinion is expressed by the followers of the infection school, that the physiological origin of spike is only a theory but that its infectious nature has been definitely established. This position is untenable. A theory is not wrong because it has not been proved. In the words of Cedric Dover, who has been working on this disease and accepts the infection theory with some qualification, 'a likely hypothesis is true till it is proved to be true or not' (Indian Forest Records 1932, pp. 37). The physiological theory, therefore, deserves every consideration, in view of the fact, that the only alternative theory, viz., the infection theory cannot be considered as definitely proved for the following reasons.

II. THE INFECTION THEORY

Sandal is nothing if not a parasite. It is a decided plurivore, capable of attacking very many hosts, and, under forest conditions, depends on the roots of a number of plants for water and nutrient salts, in addition to what it can gain directly from the soil. The minute anatomical studies of Barber and the field observations of Rama Rao and other workers notwithstanding, no one is at present in a position to state, with certainty, whether any one host, or family of host plants, will carry the sandal plant through, in its entire life cycle of 50 to 100 years. One thing is however certain that for a restricted relationship to be possible, the ideal host or hosts must be perennials, as long-lived as the sandal, and must satisfy the conditions of parasitism for a lasting relationship to be established, as in the case of certain parasites of the Striga and the Orobanche groups, for instance, which are by preference, confined mostly to the Gramineae and Solanaceae, respectively. It is therefore open to question whether any of the hosts employed like Acacias, Albizzia, Butea, Cajanus, Divi-Divi and Pongamia amongst Leguminoseae, Azadirachta, Dodonaea, Lantana, Melia. Strychnos, Zizyphus, etc., amongst other families have each by themselves really proved satisfactory hosts to the numerous research plants on which the grafting experiments have been conducted. Barber's anatomical studies rather point to tropical Leguminoseae and Zizyphus at least being anatomically unsuited to serve as hosts.

It must also be borne in mind that the mere presence of, or attachment by haustoria is no proof that a successful union has been effected, for the haustoria are formed by mechanical contact, rather than through any chemical stimulus, and they fail to function as absorbing organs in all cases, where the hosts are of an unprofitable nature and wither.

Considering therefore, that none of the plants employed as hosts in the pot cultures, have been ascertained to be good, grafting is a very doubtful method of investigating the problem, where, every sandal stock employed, is in a state of pot culture associated with a host of doubtful utility, and for this reason, the physiological condition of the stock is equally doubtful. The results obtained could only be interpreted, as proving that wherever spike has been produced, the hosts employed are unsuited or have not been successfully parasitised and in the case of others, they have served as good hosts so far, though nothing like a positive inference can be drawn, as under field conditions, not the meanest herb but

may still function as a host of some value and do its bit of service to the parasite through its rootlets. This may perhaps be illustrated by the following equation, where S stands for sandal and other letters for the different hosts $S = A + B + C + \ldots$ In the latter combination, the presence of a few useless hosts does not matter so long as there are others, on which sandal can have a good start and may depend on them and on others. It may be remarked that Lantana has earned such a notoriety in connection with spike firstly because sandal is unable to establish lasting connection on its roots, secondly, Lantana dominates to the exclusion of other tree species, which may serve as useful hosts, and, thirdly like any other weed which affects a crop, it deprives sandal and other plants of a great deal of water supply from the soil.

In view of the above considerations, grafting as an experimental method in substantiating the infection hypothesis, in the case of this particular disease, seemsfundamentally unsound. The hypothesis itself cannot work satisfactorily. It fails to explain among other things, why. if the disease spreads above ground by means of an unknown vector, the infectious principle does not kill the shoots, but the haustoria and the root ends die first, spike manifests itself only later and spiked shoots continue to live until the last stages are reached, carrying on all the vital functions, viz., absorption, transpiration, respiration and growth.

It may not really matter which theory is correct, if it is only within the region of academic discussion. When it passes this limit, the consequences need examination. As the acceptance of the infection theory involves adoption of remedial measures, like removal or destruction of valuable trees which is not contemplated by the physiological theory, the above objections should be carefully considered by the followers of the infection school, before they take the disease as definitely communicable.

II

Time of Irrigation of fruit trees.

Mr. Rajam Row, Courtallam, writes:

Is there any principle as to when trees should be irrigated. e. g. Orange and lime trees have tender shoots and blossoms are appearing. At that time could irrigation be had. Is it good or injurious? In the next stage berries will get in. Is watering them necessary? At what stages should the trees be watered.

Mr. R. Swami Rao, Superintendent, Central Fam, Coimbatore, answers as follows:-

Adverting to your letter asking for some information regarding the principle as to when trees should be irrigated, I have to state, based on my experience of the orange belt of North Arcot and Chittore and Cuddapah Districts, that no irrigation is given to fruit trees, especially to orange and lime trees at the time of their flowering or blossoming. Irrigation is however continued after the formation of berries.

If irrigation is given at the time of flowering there is a tendency for the flowers to drop down, as vegetative growth is stimulated resulting in the plant trying to give up its unessential parts viz. the flowering parts. This is very common in the case of cultivated crops, chiefly cotton, which sheds its flower buds in cloudy and rainy weather, the only exception, perhaps being chillies. For the same reason rains in the flowering season of mango trees are considered detrimental to the yield.

Gleanings.

Growth of Plants Stimulated by X-Rays. X-Rays can cause plants to grow faster, blossom earlier, form more chlorophyll, and in general speed up their life processes. But if they get too much of a dose of the rays, they become

crippled. This in brief summary is what Prof. C. A. Shull, of the University of Chicago, has found in experiments which he reported at Atlantic City before the meeting of the American Society of Plant Physiologists.

Prof. Shull exposed corn, wheat, oats and sunflowers to X-rays for periods of from one to five minutes, inclusive, under screens to take out the harmful parts of the X-ray spectrum, and also for ten minutes without the benefit of screening. He compared the growth of these plants with "control" plants that were not X-rayed at all.

All the rayed plants except the ten-minute lot apparently were stimulated by the treatment. In some cases they became juicier, or more succulent, as well as larger. In corn a considerable increase of the green food-making substance, chlorophyll was noted, running from 20 to 60 per cent. above the controls. X-rayed seeds carried on their respiratory processes with greater energy, the data indicating from 30 to 50 per cent. increase.

The three-minute treatment seemed to be most beneficial especially in the case of the sunflowers. Pots of the young plants ranged side by side mark off a curve with the graduated heights of their tops: good at one minute, best at three, not so good at five, and disastrous for the ten-minute treatment without a screen. The plants were in bud at about the same time, but the three-minute group blossomed first.

The condition of the ten-minute group indicated emphatically the effects of too much of a good thing. It was badly burned, and pecked all over the leaves, as though with a mosaic disease. The leaves were irregularly lopsided, an effect not observed at all in the plants given shorter rayings under screens (*Science* Vol. 77, No. 1984. Jan. 6, 1933).

Poisons—Their Treatment and Antidotes. Since practically all of the chemicals used in control work are poisonous to man and beast, great care has to be exercised at all times in their use and storage. However, under the best of management mistake or accident will some time occur. In such instances, emergency procedure must always be adopted because every moment becomes exceedingly precious, and while the doctor is on his way, much can be done, if one knows how, that will usually spell the difference between life and death. For this reason all packages containing poison must show conspicuously on the outside the usual symbol of such, together with the word POISON plainly marked. As well as this, the antidote and treatment for such poison or poisons present must be given.

Following is a list of the common poisons and their respective antidotes as given in the regulations:— (1) *Mineral Acids:* Sulphuric, hydrochloric, nitric and acetic acids. *Antidote*: No emetic. Give very concentrated lime water, chalk, calcined magnesia, soap suds afterwards, raw eggs, milk, sweet oil. (2) *Acid* Oxalic. *Antidote*: No emetics. Give concentrated lime water, wall plaster in paste with water, chalk, afterwards castor oil. (3) *Alkalis*: Lye, sodium hydroxide, potassium hydroxide, ammonia water, etc *Antidote*: Vinegar, dilute citric or tartaric acids, lemon or orange juice, then raw eggs, sweet oil, barley water, stimulants. (4) *Arsenic* and all compounds containing arsenic. *Antidote*; Emetic promptly, syphon tube cautiously inserted, milk, and emetic of mustard water, hydrated ferric oxide; followed by raw eggs, milk, mucilageneous drinks. (5) *Cyanides*: All compounds of hydrocyanic or pussic acid. *Antidote*: Syphon tube or emetics, cold applications to head and neck, aromatic sprits of ammonia, smelling salts, artificial respiration, brandy (per rectum), prevent sleep. (6) *Copper*: All compounds of copper. *Antidote*: Emetics, baking soda, then white of eggs, milk, sweet oil. (7) *Fluorides*: All compounds containing fluorine. *Antidote*: Calcium compounds, preferably 1% solution of calcium chloride, lime

water. (8) *Formaldehyde*, Formalin, etc. *Antidote:* Ammonium acetate solution, or well-diluted ammonia water. (9) *Iodine. Antidote:* Emetics aided by demulcent drinks, starch and flower paste, raw eggs. (10) *Lead*: All compounds of lead. *Antidote*: Emetic epsom salts in large doses, stimulating drinks, potassium iodide. (11) *Mercury*: All compounds of mercury except corrosive sublimate. *Antidote*: Immediate emetic, then white of raw eggs, milk, gruel, barley water, flour and water. Give patient all he can swallow. (12) *Corrosive sublimate*: No emetic. Give white of raw eggs and milk in large quantities. (13) *Phosphorous. Antidote*: Stomach tube, emetics, copper sulphate both as antidote and emetic (3 grains in water every five minutes till vomiting is induced) half-ounce of epsom salts, no fats or oils. (14) *Phenols*, Carbolic acid, etc. *Antidote*: Cautious insertions of syphon tube and wash out stomach with epsom salts solution, afterwards, olive oil, milk, castor oil, brandy, and warmth. (15) *Strychnine*. All compounds. *Antidote*: Emetics, strong tea, potassium bromide; keep patient still, give chloroform to prevent spasms. (16) *Sulphides*: Carbon disulphide, potassium and sodium sulphide, etc. *Antidote*: Syphon tube and wash out stomach, or 3 grains of copper sulphate in water as emetic. Afterwards milk, eggs, warmth, artificial respiration, if necessary. Alcoholic stimulants per rectum. (17) *Tobacco*: Extracts of tobacco, nicotine, etc. *Antidote*: Syphon tube or emetic, prone position, strong coffee or tea, warmth to extremities. (18) *Turpentine. Antidote*: Emetic, milk. (19) *Zinc*: All compounds of zinc. *Antidote*: No emetic, large doses of baking soda or washing soda dissolved in warm water, milk and eggs freely, strong tea. (*From Bulletin 351, April 1930, Ontario Department of Agriculture*).

Do Living Tissues emit Rays? One of the most striking of recent suggestions is that radiations may be accompaniments of certain cellular activities, and may produce effects at a distance. Thus a Russian biologist, Gurvitsch, claims to have shown that when growing cells divide, they emit rays which accelerate the processes of division in other cells. To these suggestions, Sir Frederick Gowland Hopkins gave enhanced interest, by his provisional appreciation in his Anniversary Address to the Royal Society last November. He said: " Work by many during the last year seems to have brought satisfactory proof that chemical reactions in living tissues are indeed accompanied by radiations, and events in one cell may thus influence other cells without material transmission '. " That activities in living cells may be accompanied by radiations recognisable by physical means is now, I think. a fact which is proved." It may be that this clue will lessen the uniqueness of cell-division. It certainly leads us to look at the glow-worm with fresh interest. *Scottish Jour. of Agri.* Jan 1933.

Bamboo Artificial Silk. " Experiments are being made at the Forest Research Institute at Dehra Dun, India, to produce art silk from bamboo pulp, and it is understood that partial success has already been attained. Cellulose was prepared from *Ochlandra Travancoria* (*eeta* bamboo) conforming to the specifications demanded by the artificial silk industry, but the preparation fell short to some extent of the necessary requirements. The maximum percentage of ∝—cellulose, which is the most important constituent in cellulose for the manufacture of artificial silk, is only 89—90 in bamboo pulp; the percentage of ash in bamboo pulp is also high, i. e., 0·3 % as against 0·1 % to 0·2 %, the maximum required in cellulose for artificial silk. Further experiments at the Dehra-Dun Forest Research Institute are in progress from which it is confidently hoped that it will be possible to attain the necessary high percentage of ∝—cellulose and also to reduce the ash percentage. The successful solution of the problem would encourage the establishment of a new and important industry in India and provide an additional outlet for the utilisation of bamboos (*Jour. Soc. Chemistry and Industry*. 1932. Vol. 51, pp. 864—865.)

The oldest living tree. A report states that the "Grizzly Giant" tree of Yosemite National Park in America is now considered the oldest tree living. Its height is 209 feet and its age is estimated at more than 3,800 years and recent measurements taken of the "Grizzly Giant" reveal that it would make 363,600 board feet of lumber—(*Indian Forester*, March 1933).

Crop and Trade Reports.

MADRAS REPORTS

Cotton Crop Report, Madras, Fifth or Final Report. On an average of the five years ending 1930, the area under cotton in the Madras Presidency has represented 8·9 per cent of the total area under cotton in India. The figures in this report relate to the cotton crop sown between April 1932 and March 1933. (Estimates up to the 25th March 1933.) (1) The area sown with cotton in 1932-33 is estimated at 1,976,100 acres against 2,255,200 acres for the corresponding period of last year and 1,956,100 acres in the February forecast of the current year. The present estimate for the Presidency represents a decrease of 11 per cent. from the finally recorded area of 2,228,340 acres in 1931-32. Last year's estimate exceeded the actuals by one per cent. (2) Picking of cotton is in progress and will be finished by the end of this month. (3) A normal yield is expected in Ganjam, East Godavari, West Godavari, South Arcot, North Arcot, Coimbatore, Tanjore, Ramnad and the West Coast, a yield below normal is expected in the other districts especially Guntur (75 per cent.), Bellary and Anantapur (80 per cent.). Leaf curl disease in Guntur and drought in Bellary and Anantapur are responsible for the low estimates in these districts. The season factor for the Presidency works out to 98 per cent. of the average for irrigated cotton and 89 per cent. for unirrigated cotton, the final figures for the last year being 104 per cent. and 84 per cent. On this basis, the yield works out to 411,600 bales of 400 lb. lint against 423,610 bales in the previous year, a decrease of about three per cent and against an average of 527,100 bales. It is however too early to estimate the yield with accuracy as much will depend on future weather conditions and their effect on the second crop and on the amount of damage done by insect pests. (4) The estimated area and yield under the several varieties are given below:— (Area in hundred of acres, yield in hundred of bales of 400 lbs)

Variety	Area in		Yield in	
	1932—33	1931—32	1932—33	1931—32
1	2	3	4	5
	Acres	Acres	Bales	Bales
Irrigated cambodia	183,7	151,2	111,9	92,9
Dry cambodia	141,2	129,7	28,6	26,9
Total cambodia	324,9	280,9	140,5	119,8
Karunganni in Coimbatore	114,5	114,9	26,7	27,2
Uppan in the Central Dts.	41,3	47,3	6,1	7,2
Nadan and Bourbon	40,0	37,0	2,0	1,8
Total Salems	195,8	199,2	34,8	36,2

Tinnevellies (a)	507,7	548,4	129,7	140,0
Northerns & Westerns	770,0	1,037,5	79,5	99,6
Coconadas	158,9	170,2	24,8	30,1
Others	18,8	19,0	2,3	2,4
Grand Total	1,976.1	2,255,2	411,6	428,1

(a) Includes uppan, karunganni and mixed country cotton in the South.

(5) The table below gives final information, as far as it is available on the crop of 1931—32.

(Figures in hundred of bales of 400 lbs. lint,)

Particulars.	South		Deccan	Rest of the Predency	
	Tinnevellies and Salems.	Cambodia	Northerns & Westerns	Cocanadas and others	Total
1	2	3	4	5	6
	bales	bales	bales	bales	bales
(1) Pressed at presses *plus* loose cotton received at mills in 1932—33	148,4	149,8	101,0	38,2	437,4
(2) *Add* estimate of extra factory consumption in 1932—33	6,0	nil	6,0	4,0	16,0
(3) Total crop of 1931—32	154,4	149,8	107,0	42,2	453,4
(4) Yield as estimated in April 1932	176,2	119,8	99,6	32,5	428,1
(5) Yield as estimated in the season and crop report	166,8	126,8	98,3	31,7	423,6

Note Item (1) The entries mainly relate to the crop of 1931—32. The early sown crop in the Deccan, however, generally comes into the market from December in each year. The figures are taken from the weekly returns furnished by mills and presses.

Item (2) The figures are approximate.

(3) Figures of carry over of crop and arrivals and despatches are not available.

6. The wholesale price of cotton lint imperial maund of $82\frac{2}{7}$ lb. as reported from important markets towards the close of March 1933, was Rs. 14—12—0 for Cocanadas, Rs. 16—8—0 for red northerns, Rs. 19—6—0 for white northerns, Rs. 13—15—0 for nungari (early crop) westerns, Rs. 19—3—0 for cambodia, Rs. 17—12—0 for Tinnevelly karunganni cotton Rs. 16—3—0 for nadan cotton, and Rs. 16—15—0 for Tinnevellies cotton. *(From the Board of Revenue, Madras).*

Gingelly Crop Report, Madras, Fourth or Final Report. (On an average of the five years ending 1930-31, the area under gingelly in the Madras Presidency has represented 12·5 per cent. of the total area under gingelly in India. The figures in this report relate to the gingelly crop sown between April 1932 and

March 1933). (Estimates up to the 25th March 1933). (1) The area sown with gingelly up to the end of March 1933 is estimated at 806,400 acres as against the estimate of 757,200 acres for the corresponding period of last year and the final recorded area of 747,053 acres last year. The estimate for this year is 8 per cent. above last year's actuals. Last year's estimate exceeded the actual area by one per cent. (2) 171,900 acres have been reported as sown since the previous forecast report was issued in January. as against 215,300 acres during the same period last year. These late sowings were mainly on wet lands in the Circars and the South where gingelly was raised as a second crop after paddy (3) There has been an increase in area except in Vizagapatam, Kistna, Bellary, Cuddapah, South Arcot, Ramnad, Tinnevelly and the West Coast. (4) The yield has been normal except in Ganjam, Vizagapatam, South Arcot, Chittoor, North Arcot, Tanjore and Tinnevelly where it has been below normal. The condition of the late sown crop is generally fair. (5) The seasonal factor for the Presidency works out to 97 per cent. of the average as against 96 per cent. in the previous year. On this basis, the yield is estimated at 106,500 tons as against 96,510 tons in the previous year and an average yield of 107,570 tons. (*From the Board of Reveuue, Madras*).

ALL INDIA FORECASTS

Final General Memorandum on the Sugar Cane Crop of 1932-33. The area sown is estimated at 3,305,000 acres, as against 2,972,000 acres, or an increase of 11%. The total yield of raw sugar (*gur*) is estimated at 4,651,000 tons, which exceeds the last years, record yield of 3,970,000 tons by 17%. The condition of the crop is reported to be good. The contributions of the different provinces to the total yield of cane and the acre yields are as follows. *United Provinces*—sown 1,789,000 acres 52·1% of total area yield 2,602,000 tons, acre yield 3,258 lbs. *Punjab*—sown 556,000 acres, 14·4% of total area, yield 415,000 tons, acre yield 1,672 lbs. *Bihar and Orissa*—sown 302,000 acres, 9·9% of total area, yield 313,000 tons, acre yield 2,322 lbs. *Bengal*—sown 233,000 acres, 7% of the total area, yield 454.000 tons, acre yield 4,365 lbs. *Madras*—sown 125,000 acres, 3·6% of total area, yield 346.000 tons, acre yield 6,200 lbs. *Bombay*—sown 101,000 acres, 3·2% of total area, yield 264,000 tons, acre yield 5,855 lbs. During the nine months April—December 1932, 278,285 tons of sugar were imported from foreign countries, mostly from Java (232,002 tons) and United Kingdom 23,551 tons, as against a total import of 375,271 tons in the corresponding nine months of the previous year. The annual imports of sugar have fallen from 937,662 tons in 1927–30 to 893,404 tons in 1930–31 and to 515,266 tons in 1931–32. The worlds production of sugar, both cane and beet, during 1932–33, is estimated at 23,854,000 tons, showing a decrease of 2,263,000 tons (1,678,000 tons in the case of cane sugar and 585,000 tons in the case of beet sugar), as compared with the preceeding season.

Final General Memorandum of the Cotton Crop of 1932–1933. The total area reported is 22,350,000 acres as against 23,482,000 acres, the revised estimate at this date last year, or a decrease of 5%. The total estimated yield now stands at 4,425,000 bales of 400 lbs. each, as compared with 4,088,000 bales (revised) at the corresponding date of last year. or an increase of 8%. The condition of the crop, on the whole, is reported to be fair. The provincial contributions towards the total area and yields and acre yields are as follows. *Bombay*—28·7% of total area, sown 6,395,000 acres, yield 1,405,000 bales of 400 lbs., each, acre yield 88 lbs. *Central Provinces and Berar*—19·4% of total area, sown 4,216,000 acres, yield 740,000 bales, acre yield 70 lbs. *Punjab*—10·2% of total area, sown 2,268,000 acres. yield 622 bales, acre-yield 110 lbs. *Madras*—9% of the total area, sown 1,956,000 acres, yield 420,000 bales, acre yield 86 lbs. *United Provinces*—3·1% of total area, sown 527,000 acres yield 170,000 bales acre yield 129 lbs. *Hyderabad*—14·2% of total area, sown

3,593,000 acres yield 533,000 bales. acre yield 59 lbs. *Central Indian States*—5·1 per cent. of total area, sown 1,020,000 acres, yield 139,000 bales, acre-yield 55 lbs. The distribution of the total Indian cotton crop under the different trade forms is as follows. *Oomras*—area, 10,223,000 acres, yield 1,660.000 bales, acre yield 65 lbs; *Dholleras*—area 2,586,000 acres, yield 642,000 bales, acre yield 99 lbs; *Bengal Sind*—area 2,787,000 acres, yield 752,000 bales, acre yield 108 lbs; *American*—area 862,000 acres, yield 224,000 bales acre yield 104 lbs; *Broach*—area 1,276,000 acres, yield 296,000 bales acre yield 93 lbs; *Coompta-Dharwars*—area 1,401,000 acres, yield 213,000 bales, acre yield 61 Ibs; *Westerns and Northerns*—area 1,591,000 acres, yield 202,000 bales, acre yield 51 lbs; *Cocanados*—area 189,000 acres, yield 32,000 bales, acre yield 68 lbs; *Terenevellies*—area 453,000 acres, yield 125,000 bales, acre yield 110 lbs; *Salems*—area 193,000 acres, yield 35,000 bales, acre yield 73 lbs; *Cambodios*—area 320,000 , yield 141,000 bales. acre yield 176 lbs; During the five months September 1932 to January 1933, for mill consumption Bombay consumed 492,543 bales, Madras 124.956 bales, United Provinces 116,621 bales and the Central Provinces and Berar, Bengal, Punjab and Indore about 40,000 to 50,000 bales each, the total mill consumption for India were 1,042,227 bales and exports to foreign countries 836,000 bales during the five months September 1932 to January 1933.

Trade and Economic conditions in India. The position, broadly speaking, is that, after an initial rise, prices towards the end of the period under review showed again a falling tendency, with the result that although the average level of prices on the basis of which, India's exports during 1932 were sold is slightly higher than during 1931, the general level of prices at the end of the year had fallen below the average. The most that one can say is that countries linked to sterling have fared much better than those which are still on a gold basis,

Exports. The results of the further deterioration in the general world position are reveled in India's export figures which for the ten months April to January showed a total value of 110½ crores as compared with 134¾ crores for last year. In the case of practically all the main items the decline is accounted for by a fall in the quantities rather than the price of the articles exported. This is true of the following decreases. Cotton exports 6½ crores, Jute 1¾ crores, grain, pulse and flouer about 2 crores, seeds just over 2 crores. The only exception to this under the major heads of exports is the case of tea where a slight increase in the quantity exported has been accompanied by a fall of 3 crores in value.

Raw cotton is by far the worst sufferer and during 1932 the exports had fallen in quantity by more than a half a fall which as a result of the lower prices is increased to one of more than three quarters in value as compared with the average of the past ten years For Jute, the fall in volume was about a quarter while the fall in value is more than a half. In the case of tea, although the volume of export was more than maintained, the value was reduced by more than a third. In the case of rice, the volume of export was maintained, but the value fell by over 50 per c nt. Groundnuts on the other hand show an increase in quantity but a decline in value.

Imports While the value of India's exports had thus further declined this year as compared with the last, the cause as regards imports has been strikingly different. For these at 112¾ crores for the first ten months of the current year, show a rise of about 7½ crores on the corresponding ten months of last year. Here again an examination of the actual changes in the case of the main articles of importing is interesting and suggestive. By far the largest item is the increase of just over 7 crores in cotton piece goods and yarns. It may perhaps be said that in this case exceptional factors have come into play, because the preceding period with which it compares, influenced as it was by non-economic factors

such as the boycott, can hardly be regarded as normal. The important fact to remember however, is that this increase in imports of cotton piecegoods was accompanied by a striking growth in the production of Indian mills which according to Dr. Meeks figures increased by about 11 per cent. or 284 million yards in the first 11 months as compared with 1911. It must also be noted that there has been a marked increase in the imports of other piecegoods, woollen, silk, artificial silk, and mixtures.

The increase in Indian production of cotton goods accounts for the next interesting item of increased imports on which I must comment, namely, of raw cotton, which at 6·36 crores are 79 lakhs up on last year. The steady growth during recent years in these imports is most remarkable. Taking the "cotton years" up to August 31 in each case, imports of foreign cotton expanded from just over 20,000 tons, in 1928-29 to 97,000 tons in 1931-32. Another interesting item is machinery where the imports at 9½ crores are only a few lakhs less than last year. Here these would have been of much greater fall if it had not been for a striking increase in the imports of plants for sugar factories, the imports of which in the nine months to the end of December amounted in value to 138 lakhs as compared with 30 lakhs last year and only 9 lakhs in 1929-30. In the case of certain other machinery too there have been increases which are encouraging. Thus, taking the full calender year 1932 as compared with 1931, cotton machinery increased from 180 to 208 lakhs while tea, jute and wool machinery increased by 13·3 and 1 lakh respectively.

These are the chief items of expanding imports. As against this, I must comment on the two most striking examples of declines. Imports of foreign sugar at 3·66 crores are down by 1 crores. This indicates the continuance of a steady process of decline in the value of sugar imports which for 1930-31 was about 9 crores, and in 1929-30 about 14 crores. The decline may be partly due to decreased purchasing power as evidenced by decreased consumption of refined white sugar, but I think it is a fair appreciation of the position to say that it is mainly due to the increase of Indian production. I explained last year that we estimated the production of Indian sugar to be increasing at the rate of 60,000 tons per annum, and it looks now as if this rate were being considerably accelerated.

Another striking example of decline is the case of vehicles—mainly of course, motor cars, buses and lorries, which at 304 lakhs for the ten months show a decline of 89 lakhs on last year and are less than of the value in 1929-30. (*From the Finance Member's speech on the Budget proposals for 1933-34*).

Association of Economic Biologists.

Problems of Sugarcane Research in the Provinces with special reference to Bihar and Orissa.

Under the auspices of the above Association, Mr. K. L. Khanna, Sugarcane Specialist, Bihar and Orissa, delivered a lecture on the above subject on the 13th March 1933, with Mr. G. N. Rangaswami Ayyangar, the President of the Association in the chair.

The lecturer first explained how the Cane Breeding Station at Coimbatore, was sending out a number of new seedlings for trial in the different provinces and how it took 5 or 6 years to determine which of these seedlings was the best suited to particular local conditions. Since the research schemes financed by the Imperial Council of Agricultural Research were usually for a period of 5 years, and sufficiently promising results are expected to be obtained within this

period, it would be profitable, the lecturer stated, if the investigator could devise short cut methods of work in achieving the ends in view. While thinking of short cuts a number of problems suggest themselves and these were referred to by the lecturer.

The first question to be considered was the survey of the different cane tracts. In most provinces regular surveys have already been made of the cane varieties grown in the different parts, and it has been found that only a particular type of cane was the dominant variety of individual tracts so that, these tracts are themselves classified according to the cane variety growing there; as for example, the *katha* tract of Punjab, and so on. A detailed study of the indigenous canes should tell us that it is only the seedlings that possess all the characteristics of the local variety that are likely to succeed in the tract, where that local variety is predominant. Some varieties may be able to grow in waterlogged soils and others may require loamy soils. A detailed survey of each cane tract from the varietal point of view would appear to offer promise of fruitful results.

The second consideration might be the study of the meterological conditions obtaining in the different places. Though the weekly records of the meterological data show some differences, when monthly averages are compared, such differences are not apparent in the different parts of the same province. When it is found that a seedling (Co. 213) distributed in Bihar did well in one place, and was a failure in another place only 30 miles away, the use of the meterological data to determine the suitability of particular seedlings to particular areas does not offer much hope.

The third consideration is the study of the plant itself and its response to the characters of the soil. It has often been the experience that when a seedling variety was tried in two different places, it was found that it developed a much better root system in one place than in the other. The question that naturally arises is whether it would be possible to correlate the morphological data of a variety with the composition of the soil in which it is grown. But the ordinary chemical composition of the soil failed to give any indication to the conditions of growth. It is not known whether it would be possible to correlate definite periods of growth of the plant with the soil analyses. It is probable that the examination of the physical attributes of the soil, its cohesive nature, permeability, etc., rather than the ordinary chemical composition might give an indication to the growth conditions.

In cane, varieties exhibit wide adaptablity to the environmental conditions they are grown in. Two seedlings, Co. 331 and Co. 336, grown in two places where the physical and chemical composition of the soils did not vary, still showed a big variation in their root penetration powers. In one place the penetration force was 10½ lb. and only 5 lb. in the other, though the depth of the soil was the same, very deep, in both the places. Under North Indian conditions where no irrigation is practised for sugarcane, studies on the penetrating power of roots shows a definite relation to the growth phases. When there is too much of moisture in the soil the penetrating force is less, but it increases at the time of maturity (Nov.—Feb.) when there is very little of growth, and the temperature goes down. The availability of food nutrients in the soil may vary under different conditions of soil and this should have something to do with the growth of the cane. If the penetrating force of roots of a certain variety of cane under particular soil conditions were known, the knowledge might perhaps be useful in trying this variety of cane under similar soil conditions elsewhere. The knowledge about the root penetrating force might also be useful in the trial of particular cane varieties, in soils deficient in moisture contents.

While speaking about the sugarcane root system we have to differentiate the sett and the shoot roots. The sett roots which develop first, act as water carriers and function only for a period, which varies with different varieties. The shoot roots develop later and come out in flushes. The shoot roots which develop by the middle of May show little development towards the end of June. After June these roots not only vary in size and penetrating force but also in the period of their functioning. There is probably something in the differences of the root flushes and their functioning period as they regulate the taking in of the food by the plant from the soil. Whether these differences would lead us nearer the short cuts in the methods of attack, or can be utilised for some economic purpose cannot be stated definitely. If we could correlate the differences in the root history of a particular variety grown in ten different places with the different environmental factors, we might be able to get an index as to what a new variety might behave like under these conditions. An attempt was made to see if this could be done with variety Co. 213 grown extensively in Bihar and the studies did give a qualitative index as to what characters a new variety should possess, before it can successfully replace Co. 213.

The next point to consider is the relationship between the differences in the time of root production and the application of manures, as a quicker root growth must mean a quicker response to the application of manures. Although the cultivator may not realise when best to apply the manure, it can be easily demonstrated that the best time to apply the manure is when the new flush of roots are developing. It has been found that an application of 20 lb. of N and 20 lb. of P_2O_5 in relation to the development of the root flushes gave better results than much heavier doses of manuring applied at other periods.

The study of the root system becomes useful in changing the irrigation practices. In Punjab and S. Bihar the irrigation water applied on the surface does not probably reach beyond a depth of 3 feet. Application of water without any relation to the development of root flushes might result in a big loss of water by evaporation from the surface. Irrigation in deeper layers of the soil may probably be more useful. The study of the roots has also shown that they are much stronger when the interval between two irrigations is prolonged. Another utilisation of the knowledge of the root phases comes, in making the crop stand up without lodging. The force required to pull asunder the roots varies in different varieties. This should have a relation to the moisture conditions in the soil. The determination of the pulling strain as an index to see whether the cane crop is going to stand up or not, is not satisfactory because the force of wind has to be measured in terms of pounds at any particular angle, and the force of wind may also vary from time to time and season to season. In one case, Co. 313 requiring nearly 500 lbs. force to uproot the plant lodged when the moisture content of the soil was 37 %. Lodging may in some cases be due to intensive meristamatic activity on the top portion of the crop, and in other cases, to the weakness of the roots, i. e., slower response to moisture conditions. The question of lodging leads us to the question of growing a mixture of varieties, some lodging and others non-lodging. The difficulty in this would be to decide upon the particular varieties to go in combination.

The question whether any part of the cane other than roots can be used as an index of drought resistance requires consideration. The plant has adaptable powers to different environmental conditions. In varieties Co. 285 & 320, during the hot weather in May, the leaves are found to roll inwards much more than in other varieties thus effectively reducing transpiration. Though a certain amount of relationship exists between the respiratory powers of the root and the drought resistance in some varieties of cane, the activity of the root at any moment does not show any relation to the stomata in the leaf and hence to the transpiration

rate. Dastur finds a correlation between the osmatic concentration of the leaf and the water requirements of the plant at the critical period of growth in rice. Whether root pressure determined at particular period of growth in cane, would serve as a suitable index remains to be seen. When the cane is planted, it grows slowly first and gradually increases its growth activity. The plant would probably make the most economical use of any manure applied at the time when the plant attains the peak of vitality. The manure applied earlier, when the vitality is low, may not be so useful to the plant.

Lastly, the question of using the meteorological data to work out definte correlations between it and growth phases in cane may be considered. For this work, it may not be enough if the data are recorded at one central station only. It may have to be done at a number of stations and the data used in determining the amount of growth. a cane crop would make, for a given set of weather conditions. If this could be done for definite tracts in each province, it would go a long way in simplifying the methods of breeding work.

At the end of the lecture there was an interesting discussion on the various points touched by the lecturer and he was complimented for his several thought-provoking ideas. K. R.

Review.

World Rice Situation. (*Reprint from the Foreign Crops and Markets: Issued by the Foreign Agricultural Service Bureau of Agricultural Economics, United States Department of Agriculture, Washington Aug. 22, 1932*).

The above reprint gives in brief the world's position of rice for the year 1931—32, its total production, the share of individual countries in it, and the chief countries concerned in its trade. The estimated world rice crop of 1931 outside Russia and China is placed at 131,000,000 lb., a slightly smaller figure than for 1930, but larger than any other of the preceding nine years. Though stocks continued large the prevailing low prices had drawn larger volumes of rice into international trade. Supplies were reduced in Japan and she with China have been heavy buyers in the south-east Asiatic export markets. So far as United States was concerned, the supplies were smaller because of the 1932 reduced crop, and the prices have had to be reduced to keep the movement of rice from the country in competition with Oriental and European rices. The United Kingdom and Germany, especially the latter had taken more American rice than previously. The American supplies to S. America had become reduced because of the supply from Brazil to these parts.

Among the chief rice producing countries of the east, Japan showed a drop of 17 % in production. while India (including Burma) with its large crops was the chief factor in the maintenance of the large world estimate. Regarding Indo-China and Siam, the two other important countries concerned in the production of rice, the out-turn was slightly smaller in the latter while in the former the production has been the largest since 1927. According to the detailed tables given in the report while most of the minor rice producing countries of the world do not show much of variation in the acreage and total out-put since 1910, the main rice producing countries of the east show a marked increase both in acreage and total production. India shows a 14 % increase in production and a 25 % increase in area over 1909—13 figures. The recent increase in area is particularly marked in countries like Korea, Formosa, Java, Phillippines etc.

The prices of rice in the producing countries of Europe and Asia declined very rapidly from August to the end of 1931. The price of Burma rice quoted in

Rangoon during August came down by nearly 45% during the next February, and similarly in Saigon the fall for the same period was about 26%. The very low prices offered for the Asiatic rices during the latter part of 1931 and early part of 1932 resulted in heavy exports from these countries. The declines in the prices of Spanish and Italian rices were, however, very much less than the decline in the Asiatic rices. This fall in the price of the Asiatic rices affected the usual American exports to Europe. The table giving the prices of milled rice both in the respective producing countries and in the London market from February 1930 to June 1932 shows a steady decline in the prices of all the rices, and the figures also give some idea of the disparity in the prices of rices produced in the different countries. For example, the prices of the rices (India) Burma No. 2, Indochina No. 1, and American Bluerose were respectively 1·00, 1·07, and 2·14 cents per pound, and the prices of the same in London market were 1·38, 1·35 and 2·56 cents; i. e., the American rice in England fetches nearly twice the price of the Burma rice.

British India, principally Burma, supplies the United Kingdom with 40 to 50 per cent. of its rice imports, the rest of the quantity being supplied by America and Spain, that supplied by America alone amounting to about 3 million pounds of rice annually. It is stated that there is very little competition between Burma rice and American rice in the London market, the latter evidently being much superior to the former in quality. There are provinces in India other than Burma which produce finer types of rices of as good a quality as the American Bluerose, if not even better. There are quite a number of fine rices grown in S. India and if Madras could export some of these rices to United Kingdom and manage to capture at least a share of the market now held by America and Spain it is sure to bring relief to the rice growers of S. India. This is a question that is certainly worth investigating. Similarly there is a fairly big market for American and Italian rices in Germany and central Europe to the tune of 40 million pounds of rice and the possibility of getting a share of this market also requies consideration. Commercial samples of some of the rices from S. India have already been sent to the Indian Trade Commissioners in London and Hamburg for exhibition purposes, and it is hoped they will draw the attention of the people in the respective countries.

There are interesting tables giving the exports of rice in husk, cleaned rice, boiled rice etc, from British India to specified countries in the east as well as to countries in Europe for the years 1927 to 1932. Of the total exports from India nearly half goes to the countries within the British Empire. So far as the share of the different provinces of India are concerned in this export, Burma contributes 86·5 per cent Bengal 5·8 per cent, Madras 4·6 per cent. and all the other provinces put together 3·1 per cent. (K. R.)

College News and Notes.

Students Corner. The B. Sc. degree examinations for the three parts started during the month, and with a welcome break during Easter, the practicals in the several subjects are going on vigorously. With the examination fever on, there was a lull in athletic activities but more than passing interest was provided by the Badminton Tournament, organised by the Imperial Sugarcane Station staff club at Chettipalayam, for which a number of teams from Tanjore, Trichy, Salem, Palghat and other places in the presidency entered. All the matches attracted huge crowds from Coimbatore town and the finals were played off on Saturday the 22nd, M. R. Ry. Rao Bahadur A. V. Govinda Menon, B. A., B. L., District Judge, Coimbatore presenting the trophies to the winners and runners up.

On Sunday 23rd April, a public meeting was arranged under the auspices of the Madras Agricultural Students' Union, at which speeches were made bidding farewell to the final year students and wishing them all success in their future career, and impressing on them the necessity for keeping an abiding interest in the Union; an impressive ceremony was gone through, the students one by one signing their autographs in an album especially prepared for the occasion, after which they were each presented with a momento by the president of the Union.

The Bangalore Science Meeting. About a dozen officers and students mostly from the Chemistry section attended during Easter, a joint meeting of the Indian Chemical Society and the South Indian Science Association at Bangalore, contributing several papers for the occasion.

Dr. Patel, Oil seeds Specialist attended at Simla, a meeting of the Indian Oil Crushing Committee of the I.C.A.R.

The Late Dr. Barber. Under the auspices of the Madras Agricultural Students' Union, a meeting of the residents of the Agricultural Colony was held in the College Hall on Wednesday the 15th March to express condolence at the passing away of Dr. C. A. Barber, formerly Government Botanist and Government Sugarcane Expert. A large gathering was present and several spoke movingly of the great qualities of the late Dr. Barber. A resolution of condolence was passed and the secretary of the Union was authorised to communicate the rosolution to Mrs. Barber.

Visitors. In connection with the University examinations Dr. C. J. George, Professor, Wilson College, Bombay, Mr. V. Krishnamurthy Iyer, Principal, Veterinary College, Madras, Rao Sahib C. S. Ramachandra Iyer, Assistant Industrial Engineer and Dr. Sahsrabudhe G. A. C., Bombay, visited the Institute during the month. M. R. Ry. Rao Bahadur M. R. Ramaswami Sivan, Retired Principal, Agricultural College, and Mr. R. Ramaswami Iyangar, Assistant Secretary, Development Department, were here with us for a few days during Easter. Mr. V. S. Ratnasabapathy, Organising Scout Secretary accompanied by Mr. V. C. Subbiah Gownder, District Scout Commissioner, paid a flying visit to the Estate on 19th.

Fieldmen Association. At a meeting of the above Association presided over by Mr. M. S. Purnalingam Pillay a resolution was passed, expressing condolence on the death of Mr. C. Rangaswami, Fieldman, of the cotton section who passed away after a protracted illness.

Departmental Notifications.

II Circle. B. V. Ramana, A. A. D. Guntur, l. a. p. for 12 days from 6—3—33 to 17—3—33. S. Sitapathi Rao, A. A. D. Nellore, l. a. p. for 16 days from 20—4—33 to 5—5—33 with permission to affix the holidays from 13th to 19th April, and suffix the holidays on 6th and 7th May '33. A. K. Annaswami Iyer, A. D. Kandukur, for l. a. p. for 12 days from 20—4—33 to 1—5—33 with permission to affix the Easter holidays. **III Circle.** P. Subrahmanian, A. D. Siruguppa, extension of five weeks l. a. p. on m. c. in continuation of leave already granted. A. Venkobacharlu A. A. D. Dronachalam, l. a. p. for one month from 23—3—33. **VI Circle.** K. Krishnan, A. D. Tinnevelly, extension of l. a. p. for 3 days in continuation of leave already granted. A. M. Muthiah Nattan, A. D. Dindigul, l. a. p. for 11 days from 19—3—33. **VII Circle.** A. Gopalan Nair, F. M. extension of l. a. p. for one month from 3—4—33 in continuation of leave already granted. E. Achutha Nair, A. F. M., l. a. p. for 2 months from 3—4—33. C. S. Madiah on expiry

of leave is to join duty at Cannanore, as A. D. on 1—4—33. K. M. Jacob to Taliparamba as F. M. K. S. Ramanna Rai, A. D. Mangalore, l. a. p. for one month from 20—4—33 with permission to prefix Easter and other public holidays. **VIII Circle. Transfers**: A, K. Ramasubba Iyer, A. D. Annur, to relieve P. K. Parameswara Menon, A. D. Gobichettipalayam, and will be in additional charge of Gobichettipalayam. P. K. Parameswara Menon, A. D. Gobichettipalayam will relieve H. Srinivasa Rao, A. D. Erode. H. Srinivasa Rao, A. D. Erode will relieve M. Subrahmania Pillai, A. D. Tiruppur. L. Krishnan from Palur, to Palladam sub-circle with headquarters at Palladam A D. Coimbatore will report to D. D. VIII Circle. P. P. Syed Muhamad to Tiruppur for training in office and district work and for assisting the A. D. Tiruppur in cotton ginning. T. K. Thangavelu to Gobichettipalayam sub-circle. He will however, work under the A. D. Annur for three months. **Paddy Section.** C. V. Sankaranarayana Iyer Sub-Assistant l. a p from 7th to 12th April with permission to avail on the 13th and Easter holidays. C. Rajasekhara Mudaliar l. a. p. for 15 days from 28—3—33 with permission to avail Easter holidays. V. M. Ramunni Kidavu F. M., l. a. p. for 14 days from 29—3—33 with permission to avail 12th April, being holiday and the Easter holidays. **Cotton Section.** V Gomathinayagam Pillai, Assistant in Millets l. a. p. for 14 days from 30—3—33 with permission to suffix the holidays. G. J. Balaraj, A. F. M., A. R. S. Koilpatti, l. a. p. on m. c. for 17 days from 20—3—33 with permission to avail Sunday the 19th March. P. K. Natesa Iyer. F. M., A.R.S., Koilpatti l. a p. on m. c. for 2 months and 10 days from 24—2—33. **Principals' Office.** K. Ratnavelu, A. F. M. central Farm, l. a. p. for one month from 24—3—33. **Agricultural Chemist's Section.** G. Ganapathy Iyer, Assistant, l. a. p. for 20 days from 24—3—33 with permission to suffix the Easter holidays. **D. A's. Office Orders.** The following postings of Upper subordinates, Agricultural section, are ordered from 1st April: A. Chinnathambi Pillai, A. D. IV Circle to be A.D. VI Circle R. Ananda Padmanabha Pillai, A.D. VI Circle will continue to officiate till further orders. P.P. Syed Muhamad, F. M. Central Farm, will be considered to have been officiating as upper subordinate from 20th to 31st March 1933. D. Achyutha Rama Raju, F. M. Guntur to III Circle. M. Satyanarayanamurthi, A. D. Amalapuram to Vizagapatam Division, I Circle, to report himself for duty to A. D. A. Vizagapatam Upper subordinate postings in both the Science and Agricultural sections are ordered. K. Kumaraswami Chetty officiating Upper subordinate, Agricultural section doing duty in the Oil Seeds Specialist's section to Science section to officiate as Assistant, Oil Seeds Specialist section in the permanent post declared temporary. M.J. David, officiating Assistant, Mycology section to continue as Assistant, in the Mycology section vice, K. M. Thomas on other duty. R Ananda Padmanabha Pillai, offg. A. D., VI Circle to continue to officiate in the VI Circle. M. Satyanarayanamurthi, offg. A. D. Vizagapatam to continue to officiate as A. D. in the I Circle till 31st March 1933. D. Achutarama Raju, offg. A. D., III Circle, to continue to officiate as A. D. in the III Circle till 31st March 1933. N. K. Thomas, offg A. D., VIII Circle, to continue to officiate in the same circle vice, K. Ramanatha Iyer. T. K. Mukundan, offg. F. M. Palur, to continue to officiate as F. M. till 6—7—33. S. Rajaratnam Chetty, offg. A. D. in VIII Circle to continue to officiate in the same circle. A. Muhamadali, offg. F. M. Palur, to continue to officiate as F. M. till further orders. V. K. Appaji, offg. F. M., Kalahasti, to continue to officiate till further orders. L. Krishnan, offg., A. D., VIII Circle to continue to officiate in the same circle till 10th May 1933. T. K. Thangavelu, offg. F. M., Botanical Gardens Ootacamund, to VIII Circle to officiate as A. D. till further orders. P. P. Syed Muhammad, offg. F. M. Central Farm, to VIII Circle to officiate as A. D. till further orders. C. V. Sundaram Iyer, Entomology Assistant, l. a. p. for 2 months from 20th April with permission to prefix the holiday on the 13th and the Easter holidays from 14th to 19th April, 1933.

ADDITIONS TO THE LIBRARY

FEBRUARY 1933.

A. Books.

1. Farm Management Research Technique. *R. Mcg. Carslaw.* 2. Cattle Farming in South Africa. *A. M. Bosman.* 3. Physiological & Genetical Aspects of Sterility in Domesticated Animals. *W. Orr & F. F. Darling.* 4. Proceedings of the Second Pan-Pacific Congress—1923, Vols. I & II. 5. Association Theory of Solution and Inadequacy of Dissociation Theory. *J. N. Rakshit.* 6. Madras Manual of Special Pay and Allowances (corrected up to 31—12—1932) Vol. I.

B. Reports.

1. Administration Report of the Madras Co-operative Department for 1931-32. 2. Annual Report of the Indian Lac Research Institute for 1931-32. 3. Administration Report of the Department of Agriculture & Fisheries, Travancore for 1930-31. 4 to 8. Annual Reports of the Departments of Agriculture, (a) Seychelles for 1931. (b) Washington Agri. Expt. Station for 1931-32. (c) Advisory Board of Agriculture. South Australia, for 1931-32. (d) Straits Settlements & Federated Malay States Technical Report for 1931. (e) Philippine Bureau of Science for 1931.

C. Bulletins, Memoirs &c.

1 *South Indian Fodders.* Mad. Agri. Dep. Bull. 33. 2. *Annual Supplement to the Madras Half-yearly Civil Lists—1933.* Madras Govt. Publication. 3. *Synthetic Colours versus Vegetable Dyes.* Bihar & Orissa Ind. Dept. Bull. No. 13—H. I. S. 4. *On Evaporation & Its Measurement.* Mem. Ind. Met. Dept. Vol. XXV—Part IX. 5. *Ind. Forest Records Vol. 17—4, 5, 6.* The Sutlej Deodar; Its Ecology and Timber Production. 6. The Importance of the Origin of Seed used in Forestry. 7. New Cerambycidae from India (Coleoptera). 8 to 14. *Ind. Lac. Res. Ins. Pub. Bulletins 5 to 10.* A Report on the State of Lac Cultivation & General Condition of the Lac Industry in Burma. Humidity & Storage of Button Lac. The Effects of Temperature and Humidity on oviposition, incubation and Emergence in the Lac Insect and on the Resulting Lac Crop. Orpiment and the Iodine Value of Shellac. The Iodine Value of Shellac. Comparative Study of Lac Hosts with Special Reference to Acacia Catechu & Cassia Florida. The Influence of Orpiment in Shellac on the Protective Properties of the Varnish. 15. Survey of Oilseeds & Vegetable Oils. *Emp. Mar. Board No. 61.* 16 to 18. *Min. Agri. & Fish Bull. 30, 57 & 63.* Rats and How to Exterminate them. Butter, Cream, Cheese and Scalded Cream. Fish Meal as a Food for Live Stock. 19. Nutrition in Relation to Reproduction with Special Reference to Sterility in Farm Animals. *Imp. Bur. Ani. Nutri. Tec. Comm. 2.* 20 to 22. *Imp. Bur. Agri. Parasitology Notes & Memoranda Nos. 7, 8 & 9.* Helminthology in its Application to Live Stock. Helminthology in its Applicantion to Agriculture & Horticulture. Helminths in the Biological Control of Insect Pests. 23. Report on Agricultural Meteorological Conference—1931. *Min. Agri. & Fish. Eng. Pub.* 24. The Inheritanee of Anthocyanin Pigmentation in Asiatic Cottons. *Emp. Cot. Gro. Cor. Mem. Genetics.* 25 Cotton Fibers. II. Structural Features of the Wall Suggested by X-Ray Diffraction Analyses and Observations in Ordinary and Plane-Polarized Light. *Reprint Boyce Thompson Research Institute, Vol. 4, No. 3.* 26. Herbarium Organization. *Chicago Museum Technique Series No. 1.* 27. Fifty Common Plant Galls of the Chicago Area. *Chicago Botany Leaflet—16.* 28 to 30. *Reprint, Taihoku Imp. Univ. Phyto. Lab. 10, 11, 12.* On the Relationship Between the Serological Reaction and other Biological Characters of some Putrefactive Phytopathogenic Bacteria. Immunological Studies of Mosaic Diseases: II. Distribution of Antigenic Substance of Tobacco Mosaic in

Different parts of Host Plants. Physiology & Parasitology of the Fungi Generally Referred to as Hypochnus Sasai Shirai: I. Differentiation of the Strains by Means of Hyphal Fusion and Culture in Differential Media. 31 to 44. *Canada Dep. Agri. Bull. 17 (N S.) 76, 77, 81, 89, 90, 92, 96, 99, 112, 115, 125, 132 & 137.* Hardy Roses: Their Culture in Canada Tobacco—Growing in Southwestern Ontario; A Summary of Ten Years of Experiment at the Dominion Experimental Station, Harrow Ontario. Preserving Fruits & Vegetables in the Home. Smut Diseases of Cultivated Plants: Their Cause & Control. Ornamental Trees, Shrubs, and Woody Climbers. Dehydration of Fruits & Vegetables in Canada. Manures & Fertilizers: Their Nature Functions & Application. The Conversion of Dry Roughage into a Succulent Feed: An Examination of the Sugar Jack Process. Insects of the Flower Garden and their Control. Household Insects & Their Control. Cost of Producing Farm Crops in Eastern Canada. Use of irrigation Water on Farm Crops. Poultry House Construction with General and Detailed Plans. Weeds & Weed Seeds: Illustrated and Described. 45 to 51. *Australia Council for Sci. & Ind. Res. Bull. 62, 64, 65, 66, 69, 71.* A Soil Survey of the Cadell Irrigation Area and New Era, South Australia. The Ripening & Transport of Bananas in Australia. Downy Mildew (Blue Mould) of Tobacco in Australia. The Influence of Growth Stage and Frequency of Cutting on the Yield & Composition of a Perennial Grass—Phalaris tuberosa. An investigation of the Taxonomic & Agricultural Characters of the Danthonia Group. Investigation on Irrigated Pastures: 1. The Yield & Botanical Composition of an irrigated Permanent Pasture under various Systems of Pasture Management. 2. The Chemical Composition of Irrigated Pastures at Wood's Point, South Australia. 52 to 56. *Austria Council for Sci. Pamphlets 25, 29, 30, 31, 32.* Termites (White Ants) in South-eastern Australia: A Simple Method of Identification and a Discussion of their Damage in Timber & Forest Trees. The Possibility of the Entomological Control of St. John's Work in Australia—Progress Report. The Bionomics & Economic Importance of Thrips imaginis Bagnall: with Special reference to its Effect on Apple Production in Australia. A Preliminary Report on Investigations on the Buffalo Fly (Lyperosia—exigua de Meij.) and its Parasites in Java and Northern Australia. The Chemistry of Australian Timbers Part 2—The Chemical Composition of the Woods of the Ironbark Group. (Division of Forest Products—Technical Paper No. 4) 57. *Nyasaland Dep. Agri. Bull. No. 5 (N. S.)* Mosquito Bug the cause of Stem Canker of Tea. 58 & 59. *Union S. Africa Agri. Dep. Sci. Bull. Nos. 80 & 118.* Moulds and Their Control in the Dairy, Pernicious Scale. 60. *Transvall University College T. U. C Bull. 12.* Rainfall & Farming in the Transvaal. Part I—A Preliminary Investigation into the Variability of the Rainfall of the Transvaal. Part II—Rainfall in Relation to Agriculture in the Transvaal. 61. *Univ. of Pretoria Bull. No. 20.* Digestibility of Teff Hay, Maize Oil Cake and Lucerne Hay for Cattle: A Report on Digestion Trials Conducted at the University of Pretoria. 62 to 67. *Sultanic Agri. Soc Tech. Sec. Bull. Nos. 2, 4, 5, 7, 8, 9.* Some Aspects of Bacteriological Activity in Egyptian Soils. A Study of Nitrogen and Root Space as Factors Limiting the Yield of Maize in Egypt. The Digestibility of Bersim (Trifolium Alexandrinum). Some Observations on the Growth of Maize in Egypt. Farmyard Manure in Egypt. Moki Lima Beans. 68. An Economic Study of Agriculture in Northern Livingston County, New York. *Cornell Univ. A. E. S. Bull. 539.* 69 & 70. *Oklahoma A. E. S. Bull. 205 & 206.* Easily Soluble Phosphorus in Oklahoma Soils. Soil Fertility and Sweet Clover Production in Oklahoma. 71. Studies on Summer Cover Crops in a Pineapple Orange Grove. *Florida A. E. S. Bull. 253.* 72. Growth and Decline of Farm Trade Centres in Minnesota, 1905–30. *Minnesota A. E. S. Bull. 287.* 73. The Relation of Feather Pigmentation to Intensity of Laying in Rhode Island Reds. *Massachusetts A. E. S. Bull. 288.*

D. Leaflets, Circulars &c.

1. Compost Manure From Farm Waste by the Indore Method. *Indore Inst. Plant Ind. Leaflet No. 1.* 2 to 4. *India Lac. Res. Inst. Res. Note Nos. 1, 2 & 3 June' 32.* A Note on Bleaching Shellac. A Note on Determination of Shellac Fluidity. A Note on the Swelling of Shellac. 5. Production and Trade on the British West Indies, British Guiana, Hermuda & British Honduras. *E. M. B./T. P. 24.* 6 to 9. *Mm. Agri. Fish. Adv. Leaf. 151 to 154.* The Cultivation of Parsnips. The Culture of Green Peas and Beans. Mange in Cattle. Fruit Tree Capsids. 10. The Dorsett, Fairfax, and Narcissa Strawberries. *U. S. A. Dept. Agri. Cir. 257.*

E. Reprints.

1. List Showing the Available Publications of the Agricultural Department, Madras. 2. World Rice Situation, U. S. Dept. Agriculture Bureau of Agricultural Economics.

The Ramasastrulu–Munagala Prize, 1933.

1. The prize will be awarded in July 1933. 2. The prize will be in the form of a Medal and will be awarded to the member of the Union who submits the best account of original research or enquiry, carried out by him on any agricultural subject. 3. The subject matter shall not exceed in length twelve foolscap pages type-written on one side. 4. Intending competitors should notify the Secretary of the Madras Agricultural Students' Union not later than the 15th May the subject of the paper which they propose to submit and the paper should be sent in so as to reach the Secretary, Madras Agricultural Students' Union not later than the 1st June 1933, with a covering letter showing full name and address of the sender. The author's name should not be shown on the paper but should be entered under a nom de plume. 5. Four type-written copies of the essay should be sent in. 6. The name of the successful competitor will be announced and the prize awarded at the time of the Conference. 7. Papers submitted will become the property of the Union and the Union reserves to itself the right of publishing all or any of the papers. 8. All references in the paper to published books, reports or papers by other workers must be acknowledged. 9. Any further particulars may be obtained from the Secretary, Madras Agricultural Students' Union, Lawley Road, P. O., Coimbatore.